

**Proposed Allen County Regional Landfill (ACRL) Postclosure Care (PCC)
Reduction and/or Termination Report (7-16-15)**

***Inserted Italicized Notes:** These are not considered part of this proposed report (designated **ACRL Report**) but they provide explanations and facts related to the **ACRL Report** and will be useful to landfill owners/operators (O/O) who want to prepare their own revised plans. A copy of the **ACRL Report** without the inserted notes, references and appendices is given in Appendix 5.*

***Note 1:** Numbers in parentheses are references which are available at the ACRL; the Bureau of Waste Management (BWM) or Bureau of Air (BOA) websites (1), bureau document storage systems (hard copies in file rooms or electronic copies in respective bureau **Image Now** systems) in the Kansas Department of Health and Environment (KDHE), and other publications available on the Internet.*

***Note 2:** This **ACRL Report** is based on the fact that the pre-Subtitle D portion of the ACRL landfill closed in October 2001; Phases I and II became inactive (final or certified closure will occur when Cells 1A and 1B reach their design elevations) in November 2002 and February 2010, respectively. Each of these units have separate leachate collection points, which can allow the reduction of PCC activities as specified in the BWM Policy 2014-P2 entitled **Reduction and/or Termination of Postclosure Care Activities** (2). Major activity categories include: groundwater monitoring, leachate collection system operation and monitoring, gas monitoring at facility boundaries and in the gas collection and control system (GCCS). However, it should be noted that four of the five years of leachate samples for Phases I and II along with Cell 1A were collected from the storage and evaporation basin (SEB No.1) instead of the wet well influent, which consists of comingled Phases I and II leachates. SEB No. 1 replaced the old leachate storage tank at the same time that Phase II MSW disposal ceased. Currently, SEB No. 1 “leachate” consists of leachate from Phases I and II, Cells 1A and 1B as well as water losses from evaporation and gains from precipitation. Pre-Subtitle D leachate is collected from a toe drain sump near the sediment pond.*

It is recognized that not all Subtitle D landfills have separate leachate collection points for each of their closed units so that fresh unit samples can be collected, i.e., all the leachate from the units flow to a common collection point like a sump.

Also, it is recognized that leachate collection systems evolve as new units are engineered. It is preferable that separate unit leachate sampling be done so that the leachate data are comparable in terms of the stabilization occurring in the separate units. It may be possible for unit piping to be retrofitted to allow the collection of unit leachate samples and the measurement of unit leachate flow rates.

***Note 3:** The above referenced policy statement seems to be in conflict with the existing regulations for some of the above mentioned activities, e.g., the possibility of eliminating gas measurements in structures. The regulations do not recognize that during PCC many of the groundwater and emission events can change significantly to the extent that doing the regulated activities would be meaningless. The policy statement recognizes this possibility and allows the reduction and/or termination of the identified activities. Given the conditions cited in the proposed modifications document (3); reduction and/or termination of activities are possible for the **ACRL Report**.*

***Note 4:** Note 3 will not be necessary once the final PCC regulations are approved since recent policy and technical guidance documents will be incorporated in the promulgated regulations.*

***Note 5:** Some Subtitle D landfills are affected by ordinances of the local jurisdiction; hence, they must meet these ordinances including State and Federal regulations. The ACRL is not one of these landfills.*

Note 6: Other formats can be used to write an **ACRL Report**. The important point is that the **ACRL Report** should adhere to the BWM Technical Guidance Document SW-2014-G1 entitled **Preparation of Postclosure Care Reduction and/or Terminations Plans** dated 5-2-14 (4).

Introduction

The objective of this proposal is to present the current ACRL Closure and Postclosure Plans (see Appendix I) along with existing monitoring requirements; and to present the **ACRL Report** which will enable the ACRL to reduce and/or terminate certain PCC activities for the purpose of reducing costs without compromising health or safety or the environment. The **ACRL Report** will define what changes are actually being proposed and why. It is based on actual but limited data and, in some cases, assumptions, so that different aspects of activity reduction and/or termination can be demonstrated.

Note 7: It was not considered necessary to collect and analyze all the available ACRL monitoring data because of the need to obtain these data from ACRL, BWM or BOA sources would be very time consuming. Also, it should be recognized that a data gap exists between the **ACRL Report** data used and the time the report was completed. Finally, real data did allow the preparation of the **ACRL Report** which serves as an example to other Subtitle D landfills that will have ready access to all of their data as required by law and by landfill needs.

Strategy for the Preparation of an ACRL Report

The existing Closure and Postclosure Plans in Appendix I and the following section describe and define the existing monitoring requirements corresponding to the current plans. The monitoring requirements offer financial incentives for the preparation of the **ACRL Report**. Other related cost savings are possible in the areas of: security, regulatory, hydrology, weather, surface maintenance, settlements and seeps, public concerns, land use and financial assurance. An example for surface maintenance would be the reduction in final cover care due to the stabilization of the stored MSW and, hence, the cessation of surface subsidence which would help minimize the final cover maintenance and placement needs.

Existing Monitoring Activities

Monitoring activities are required by Bureau of Waste Management (BWM) and Bureau of Air (BOA) regulations. They were performed in the past by Burns & McDonnell (B&M) and are currently being conducted by ACRL consultants: Schwab Eaton and AEI. Table 1 (at the conclusion of this section) summarizes these activities. Emission considerations for fugitive sources like haul roads and the fuel storage tank are not included in Table 1 since they are estimated from generic data sources.

Groundwater Monitoring [KAR 28-29-113(a) and (b)]

Subpart (a) deals with detection monitoring and subpart (b) deals with assessment monitoring requirements. The latter requirement is initiated if there is a statistically significant increase in the background concentration for one or more constituents or if the background concentrations have not been established by prior monitoring [see **KAR 28-29-113(b)(1)(A) and (B)**]. BWM staff review the semiannual sampling results to see if the above monitoring requirements are satisfied. To date, there have been no exceedances nor has there been a failure to establish background concentrations.

Based on the January 7, 2013 Burns and McDonnell (5) groundwater monitoring report, there are 19 active shallow wells and 15 active medium depth wells. Monitoring and piezometer wells are located around and within the landfill site. There are no active monitoring wells in the closed, inactive or active MSW disposal sites (pre-Subtitle D and Subtitle D Phases I and II, and Cells 1A and 1B; and C&D and Industrial Waste sites). The earliest wells were installed in 1994 and the latest in 2010. Nine shallow and five medium wells have been plugged and abandoned because of landfill expansions.

Leachate Monitoring [KAR 28-29-104(i)(6)]

Annual leachate sampling of each unit is required [see **KAR 28-29-104(i)(6)(A)**]; however, at the ACRL leachates from inactive Phases I and II are comingled in a gravity fed wet well as are currently inactive Cell 1A and active Cell 1B leachates which comeingle in a common sump (as will the A and B portions of future Cells 2 to 4). Also, leachate samples, since the construction of SEB No. 1, have been taken from the surface of the basin near the northeast corner where both leachate streams (Phases I and II, and Cells 1A and 1B) discharge into the SEB. The most recent (do not include additional samples taken up to the date of this report as per **Note 7**) samples of October 30, 2014 were undefined composites of Cells 1A and 1B discharge stream at the retention basin and from the lift station which is comprised of Phases I and II discharges. BWM staff took **quarterly** leachate samples from the Phases I and II, and Cell 1A during 2012 and 2013. Samples of leachate from the closed pre-Subtitle D unit's toe drain are taken from a sump near the sediment pond. Part of this drainage comes from an area which is below Phase II's lined cell (The toe drain section below Phase I is solid pipe.).

Gas Monitoring in Structures and the Facility Boundary [KAR 28-29-108(e)]

Quarterly monitoring is performed to insure that explosive conditions do not develop in structures or at the facility boundary. There are **continuous** gas monitors in the maintenance building and there are 12 gas monitoring probes located along the northern and eastern boundaries of the landfill.

Gas Monitoring of Landfill Gas (LFG) from the Gas Collection and Control System (GCCS) [KAR 28-29-108(h) and Clean Air Act, §60.752(b)(2)(ii)(A)]

The current GCCS was installed by ACRL to prevent off-site LFG migration from the unlined pre-Subtitle D cell subsequent to the cell's capping. The GCCS uses a flare to combust captured LFG and the ACRL has an air emission source Class 1 operating permit issued by the BOA. The permit covers emissions from the landfill, haul road and a diesel storage tank. This postclosure care (PCC) discussion only addresses LFG emissions.

In 2008 the ACRL's MSW approved design capacity was increased by a horizontal and vertical expansion to approximately 6.57 million cubic yards and 3.61 million tons, about 5.03 million cubic meters (m³) and 3.28 million megagrams (Mg), respectively. According to the New Source Performance Standards (NSPS) presented in **KAR 28-19-720 40 CFR Part 60, Subparts A and WWW** the expansion resulted in the ACRL classified as a "new landfill." As a new landfill, because either of the respective cited capacities exceeds the 2.5 million m³ or 2.5 million Mg limits at which NSPS apply, the ACRL is subject to the NSPS. Because of this, the air emission permit requires operating the GCCS in conformance with the NSPS presented in **Subpart WWW**. The currently applicable NSPS requirements consist of annually estimating the ACRL's non-methane organic compound (NMOC) emissions using techniques prescribed by **Subpart WWW**.

Installation of an expanded GCCS control system in areas where waste has been in place greater than five years will be required within 30 months of LFG NMOC emissions exceeding 50 Mg per year.

Monthly pressure measurements are made in the pre-Subtitle D closed landfill at the gas collection header of each individual well [**§60.755(a)(3)**]; also, oxygen and temperature are measured at each well [**§60.755(a)(5)**].

Gas Monitoring of Flare and Surface Emissions

The collected LFG is burned in a flare where site personnel make **weekly** measurements of flow, methane, carbon dioxide, oxygen and other gases. A landfill GCCS chart recorder measures system vacuum; inlet temperature, flow and pressure; and flare temperatures at **10 minute intervals**.

Applicable regulations include **KAR 28-19-650** for flare emission opacity and **KAR 28-19-750 (40 CFR Part 63, Subparts A and AAAA)** for National Emission Standards for Hazardous Air Pollutants (NESHAPs) maximum achievable control technology (MACT) requirements. Flare performance requirements are presented in **40 CFR Part 60.18(c) to (f), and 60.752(b)(2)(iii)(A)**. LFG extraction system performance requirements are presented in **40 CFR 60.752(b)(2)(ii)(A)**. Record keeping requirements related to the flare and LFG extraction are presented in **40 CFR 60.7 and 60.756**.

When the expanded GCCS system is installed, the quarterly surface monitoring required by **40 CFR 60.753(d)** will be initiated. The expanded GCCS will remain in operation until the landfill closes and three consecutive annual NMOC calculations present NMOC emissions less than 50 Mg.

ACRL monitoring activities are presented in Table 1. GCCS monitoring follows Clean Air Act NSPS requirements. Activities that will be required in the future, either due to cell construction or when an expanded GCCS is necessary are presented in italics.

Table 1 – ACRL Monitoring Activities

Monitoring Activity/Bureau monitoring results	Location(s)	Frequency	Parameters
Groundwater/BWM	Multiple monitoring wells	Semi-Annual	KAR Appendix I (Geochemicals & volatile organics for detection monitoring)*
Leachate/BWM	Pre-Subtitle D toe drain sump, Phases I & II wet well, Cells 1A & 1B SEB inlet & SEB No.1 <i>future cells' SEB inlets</i>	Biannually and Quarterly	Flow, KAR Appendix I* (see above), BOD ₅ , TSS, total iron & pH
Landfill gas at wells and flare inlet header/BOA	Multiple wells	Monthly at wells and weekly at flare	CH ₄ , CO ₂ , O ₂ , balance gases, pressure & temperature
Flare emissions/BOA	Flare	Recorded continuously every 10 seconds at flare	System inlet pressure, flow rate, temperature, bypass flow rate, actual exit velocity & average combustion temperature
<i>Surface emissions (two to four inches above the landfill surface)/BOA</i>	<i>Areas with installed LFG extraction wells</i>	<i>Quarterly</i>	<i>CH₄ above background</i>
Boundary emissions/BWM	North & east edge of landfill	Quarterly	CH ₄
Structure emissions/BWM	Maintenance building, office & storage shed	Weekly & Continuous	CH ₄

*See **KAR 28-29-113(c)**.

ACRL Report Considerations

As stated in the TGD SW-2014-G1 (4), the goal of the **ACRL Report** is “to describe the methodology that will be used to:

- Predict a time when certain PCC activities may be terminated (before, at, or after 30 years); and
- Demonstrate that a particular PCC activity may be reduced or terminated without risk to public health or safety or the environment.”

Also, “The proposed trend methodology to determine when one or more PCC activities may be reduced and/or terminated will involve a minimum of 3 major evaluation periods of at least 5 years each where each period is statistically verifiable. The determination of equilibrium for leachate and landfill gas emissions can be accomplished by quarterly sampling over a 5-year demonstration period, during which there is no statistically significant difference in key parameter values with time. If there is a statistically significant difference in any of the key parameters, a new 5-year demonstration period must begin. After 1 demonstration period in which key parameters are shown to be in equilibrium, reduction of appropriate activities may begin, after approval by KDHE. After 3 consecutive demonstration periods in which key parameters are shown to be in equilibrium, appropriate activities may be terminated, after approval by KDHE.”

Appendix 2 gives a chronology of unit changes for the ACRL. This historical review provides key dates for the opening and closing of landfill units that are affected by the preceding reduction and termination criteria. Projected dates for unit activity changes are given in Table 2.

Note 8: *The final closing of abutting Subtitle D units will not take place until one or both units are at their final elevations less final cover thickness. It is possible that units may be inactive for a period of time after initially reaching this final elevation to allow for waste settling and additional waste placement. For Cell 1 and Phases I and II, which will reach their final elevation approximately concurrently, final cover may not be installed until about 2028. At this time, due to the overlapping nature of waste placement (Cell 2 wastes placed on Cell 1 slopes and draining to the Cell 1 leachate recovery system), only Phases I and II will be eligible for PCC reduction. For this reason, this report primarily discusses performance at the already closed, pre-Subtitle D area.*

It is anticipated that closure cover will be installed on the Subtitle D units in a south-to-north direction.

The choice of final cover will have a major impact on the time required for the MSW stabilization process to reach equilibrium within a given cell. An impervious synthetic cover will allow the MSW stabilization process to reach equilibrium sooner since the lack of water input will stop the stabilization processes; the reverse is true for a permeable cover. Also, LFG recovery with a GCCS will be increased. A pervious cover will facilitate the long term stabilization of the MSW with a lower LFG collection efficiency.

Note 9: *A final impervious cover for the pre-Subtitle D unit was put in place in 2002. Also, it is assumed that impervious covers will be put on Subtitle D Phases I and II, and Cells 1A, 1B and the remaining cells in the order after the subsequent units close (3).*

Note 10: *As stated in Note 2 and Appendix 2, only the pre-Subtitle D is closed and Subtitle D Phases I and II have been inactive for at least 5 years; therefore, the earliest times for activity changes for the currently closed units are as shown in Table 2. Cells 1A and 1B are not close to their final grades; and hence, cannot be considered for reduction and termination changes at this time. Because they have a common leachate sump their earliest dates for considerations is dependent on the closure of both units. Of course, each 5 year*

period must have statistically demonstrated equilibrium conditions where emission values are determined quarterly. Unfortunately this is not the case with any ACL unit. Hence, as stated in **Note 7**, emission conditions will be assumed to demonstrate the **ACRL Report** methodology. In reality, if the real and/or assumed conditions do not demonstrate that equilibrium has been achieved, then the dates given in the table must be changed to allow the 5 year requirements to be met.

Table 2 - Projected Dates* for Unit Activity Reduction or Termination

Unit	Pre-Subtitle D	Phases I & II	Cells 1A & 1B
Date Closed	October 2001	Anticipated 2028 (Currently Inactive)	Estimated 2050 (Cell 1A inactive, Cell 1B active)
5 Year Period (Reduction)	October 2006	Anticipated 2033	Estimated 2055
15 Year Period (Termination)	October 2016	Anticipated 2043	Estimated 2065

* Based on last unit closed in unit categories.

Note 11: Part of the **ACRL Report** will be based on assumptions of future activities and their resultant data. A major part of the plan is to provide a monitoring program for selected parameters of the groundwater, leachate and LFG (including the wells and the flare in the GCCS and the boundary, structures and surface emissions) to validate the assumptions. The selection of the suite of parameters to be measured for the various emissions are defined by regulations and recommended key parameters for leachate and LFG. Although not discussed in this document, it is important that parameters which have published MCLs should be monitored over time until they demonstrate that they fall below and will remain below the stated MCL. No attempt was made to identify such parameters for this document.

ACRL Report

Note 12: It is assumed that the **Proposed Modifications to the ACRL Facility Operating Plan (FOP)(3)** were approved and serves as a starting point for the following **ACRL Report**. It is possible that subsequent modifications could be approved; hence, they would be cited as reference documents for the **ACRL Report**.

The basis for the **ACRL Report** is the latest approved FOP (5) and subsequent approved modifications which might occur after the latest amended FOP. The proposed (assumed approved) modifications are given in Reference 3. TGD SW 2014-G1 (Reference 4) gives General Requirements and Plan Contents for the **ACRL Report**. The following sections of the **ACRL Report** are based on these requirements.

Note 13: The latest approved FOP would likely be modified at some point into the PCC period for the units in question since the **ACRL Report** must have adequate data to become approved. Later modifications could occur after this since there are still active disposal units.

Trend Parameters

The key parameters to judge whether a trend exists which can result in a reduced or eliminated monitoring activities for the pre-Subtitle D toe drain and LFG wells; and for Phases I and II leachate were given in Table 1 in the previous section entitled **Existing Monitoring Activities**. Groundwater, flare, surface fugitive, boundary and structural emissions are considered supplemental parameters because

they do not directly reflect the results of the MSW stabilization processes or the duplicate LFG measurements as determined at the individual wells. These other LFG monitoring results are affected by the ameliorating effects of the actual and assumed final cover materials.

1. Leachate Parameters

The key leachate and LFG parameters as shown in Table 1 are by-products of the MSW biostabilization reactions occurring within the landfill mass. They are distinct from the other reactions, e.g., physical solution of MSW components which are non-biodegradable and the chemical reaction of MSW components reactive with water. The selected leachate parameters represent the response of microorganisms to the biodegradable portion of the MSW but do not reflect the nature of the MSW itself, except to say that it can be used as a food source by the microbes. It should be noted that some of the MSW is not biodegradable.

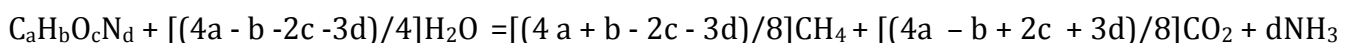
The five day biological oxygen demand (BOD₅) leachate parameter indicates the amount of biodegradable food remaining in the leachate, e.g., the Phases I and II values for quarterly sampling in 2012 to 2013 were 13, 16, 17 and 16 mg/L, which is very small compared to the BOD₅ of MSW. The corresponding chemical oxygen demand (COD) values were 190, 250, 110 and 140 mg/L; also small in comparison to the undigested MSW. COD values include the BOD₅ results and a non-biodegradable portion. Typically, this portion is much larger than the biodegradable portion. The values are more variable than the BOD₅ values but this is not unusual since they reflect a more diverse organic source. Total suspended solids (TSS) represents part of this diversity in that it can include insoluble organics which are COD oxidizable; but more than likely, TSS represents microbial solids washed off the MSW mass into the leachate. Corresponding TSS values for the previously presented quarterly BOD₅ and COD values are 28, 24, 39 and 32 mg/L; which are more consistent than the COD values but less than the BOD₅. The pH values were 7.3, 7.7, 7.5 and 6.8. They represent an acceptable range for the survival of the microbes digesting the MSW. The lower value of 6.8 could be an indicator of a buildup of organic acids which would lower the pH despite the high alkalinity values (984, 954, 865 and 972 mg/L). Alkalinity is a measure of the buffering capacity of the leachate. It represents the ability of the leachate to resist the change in pH due to the addition of an acid. Acids are produced in the stabilization process. They are typically degraded by the methane formers (see subsection 2 below).

The other key leachate parameter is ammonia, NH₃. Values measured were 75, NA (not analyzed), 50 and 48 mg/L. These values indicate that the microbes attached to the MSW mass and released into the leachate had undergone endogenous respiration which results in the loss of NH₃. Although oxidizable in an aerobic environment, NH₃ will build up in an anaerobic or reducing one. It is well known that NH₃ levels will increase as MSW stabilization continues.

The measurement of flow allows the mass flow rate of these key parameters to be determined. This is important since it takes into account the total amount of pollutants in the leachate. Corresponding flow values are not available for these quarterly samples.

2. LFG Parameters

Methane, CO₂ and NH₃ are by-products of MSW anaerobic digestion which occurs as follows (6):



This reaction occurs in two steps; the first step produces organic acids which are then digested in the second step producing CH₄ (also, CO₂ and NH₃). Again, like for leachate, CH₄ production is an indication that MSW stabilization has occurred. LFG analyses for 8-2-12 (which are prior to the quarterly leachate results starting in 10-9-12) show CH₄ values of 54.2, 61.7, 61.0, 56.2, 61.7, 0.3, 0.1, 44.7, 35.1, 17.7, 58.4, 59.6, 49.9, 47.5, 36.0, and 28.9 volume percent for wells 1 to 16, respectively. Corresponding CO₂ values are: 35.0, 36.9, 34.0, 29.3, 26.2, 0.1, 0.0, 25.7, 26.2, 14.7, 32.9, 32.3, 32.6, 29.8, 29.0 and 30.0.

Several points need to be recognized regarding possible LFG composition trends. First, multiple well results are available and each well is affected by the vacuum applied to the well because low vacuums will not draw fresh LFG to the wellhead as desired. Second, there are more wells than there are leachate collection points. An alternate point of sampling LFG would be at the intake to the flare where the gas composition would be most strongly affected by the well with the greatest vacuum although it should be a composite of all the GCCS wells even though the wells with the lesser vacuums do not contribute as much gas to the flare as the well(s) with the greatest vacuum(s). Lastly, the state of the MSW stabilization for LFG production varies with the degree of stabilization as shown in Figure 1 for the hypothetical batch stabilization of MSW (7) (Note that actual stabilization curves for MSW landfills can take years to evolve since they depend on the availability of moisture). The ratio of CH₄ to CO₂ increases as time passes from the start of Phase IV to about the midpoint of Phase IV. The decline afterwards is a result of the consumption of the total volatile acids (TVA) which serves as a food source for the methane bacteria as stated previously.

As MSW stabilizes, the LFG gas compositions should level out as shown in the latter part of Phase IV. The key point to note is that gas production will decline as shown in the latter part of Phases IV and V. This would suggest that the best way to determine a trend for LFG is to track gas production. The CH₄/CO₂ ratio can be used as a secondary trend factor for the reasons cited previously.

Figure 1 – Extract from Reference 8

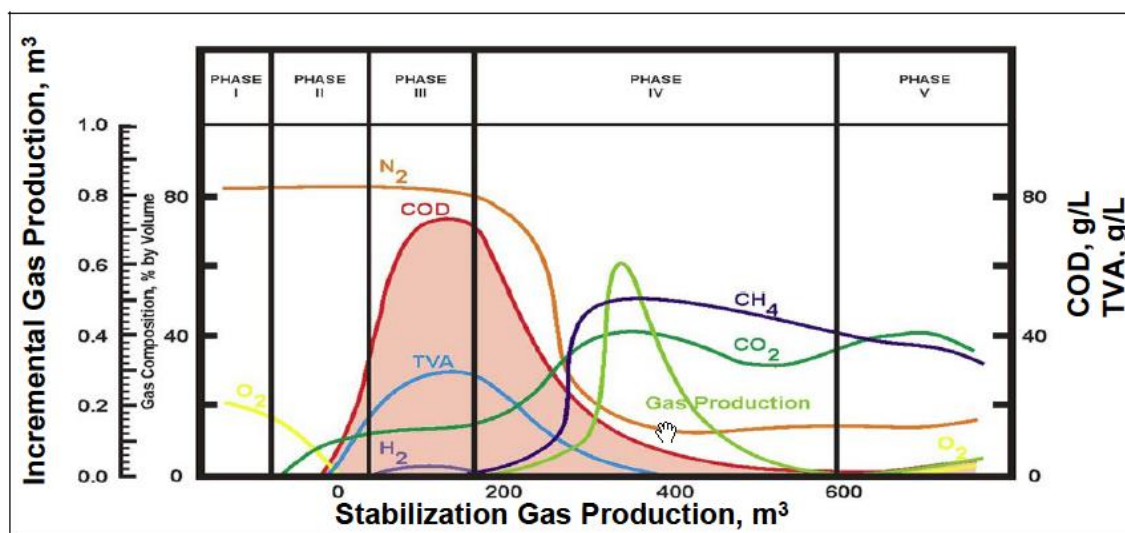


Figure 1-4. Waste decomposition phases taken from draft
(Modified from Pohland and Harper, 1986)

Available Results, Trend Analyses Conclusions and Recommendations

Reference 4 states that trends to establish equilibrium of key parameters need to be validated by statistics. Reference 8 gives a procedure (along with an available PowerPoint™ demonstration) to do this

using the non-parametric Kendall tau statistic. However, this procedure will not be used to confirm equilibrium for the various emissions reviewed in this section due to the time constraints in doing the numerous evaluations manually. General conclusions will be reached based on the observed (and in some cases an assumed) trend of each of the emission sources under consideration as far as the possibility of activity reduction or termination.

Note 14: *The Kendall tau or another non-parametric statistical method must be used by all landfill O/O to validate all emission data for trends and to establish equilibrium conditions for the individual parameters.*

1. Leachates

Table 3 data consists of pre-Subtitle D leachate results from toe drain sampling done by B&M. The data do not include the first five years following closure and only one year (2011) where quarterly samples were taken. There are 15 sets of data covering a nine year period as shown in Figure 2. In general and ignoring what could be called an outlier, it can be concluded that the leachate from the pre-Subtitle D landfill is relatively stable except for a downward trend in COD and NH₃ fluctuations; the latter of which are expected, but are not extreme. Therefore, it is recommended that the toe drain analyte list include COD and NH₃ measurements after 2016 until subsequent equilibrium values are obtained.

Toe drain volumes have been recorded since May 2004. No attempt was made to determine any trends in the volume data but there should be a direct correlation with precipitation data since the pre-Subtitle D unit is an unlined cell, which allows for infiltration through the quarry walls. The pre-Subtitle D area has a composite (clay plus HDPE) final cover. Available toe drain volumes are included in Appendix 3. There are only two data which match the leachate data in Table 3 if one matches a date in Table 3 with a month in Appendix 3; hence, there is only one mass flow value that can be calculated. Also, Table 3 data are for grab samples taken on particular days and Appendix 3 data are haul data for a particular day which are typically not the same day, i.e., leachate sampling did not occur on the same day when the toe drain wet well was emptied into a haul truck for disposal. There should be better comparisons for future values since toe drain analyses and haul data are routinely recorded.

Table 3 – Key Leachate Data for Toe Drain

Sampler	Date	BOD ₅ (mg/L)	COD (mg/L)	TSS (mg/L)	NH ₃ -N (mg/L)	pH
B&M	2-1-06	11	250	6.7	0.55	7.5
B&M	4-19-06	7.0	250	18	80	7.3
B&M	8-2-06	22	290	9.0	68	6.8
B&M	1-25-10	BDL	240	13	54	7.7
B&M	4-14-10	23	190	8.6	46	7.9
B&M	9-1-10	11	180	2.1	10	8.3
B&M	10-13-10	8.1	200	5.6	4.1	7.4
B&M	1-13-11	19	240	3.2	34	7.9
B&M	4-28-11	48	210	32	26	7.9
B&M	7-19-11	18	210	66	3.9	8.4
B&M	10-18-11	30	250	36	150	7.4
B&M	4-19-12	mentioned	but not	available	in GW	report
B&M	10-9-12	10	200	5.9	66	7.0
B&M	4-10-13	11.0	180	12	58	7.0
B&M	10-10-13	mentioned	but not	available	in GW	report
SE (B&M)	4-16-14	7.40	170	18	53	6.7
AEI	10-30-14	5.2	147	1,120	72.3	7.0
	Average	16	214	90	48	7.5
	Average w/o outlier	No outliers	No outliers	16	No outliers	No outliers
	Range	5.2 to 48	147 to 290	2.1 to 1,120	0.55 to 150	6.7 to 8.4
	Range w/o outlier	No outliers	No outliers	2.1 to 66	No outliers	No outliers

Figure 2

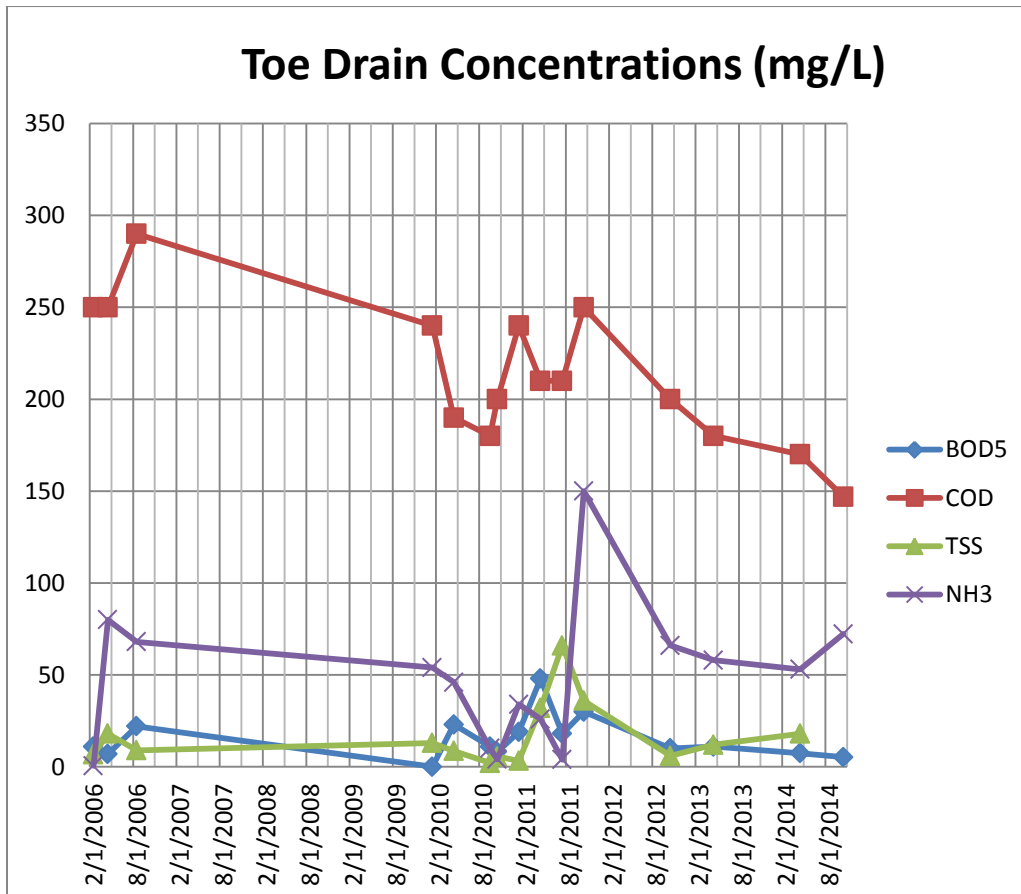


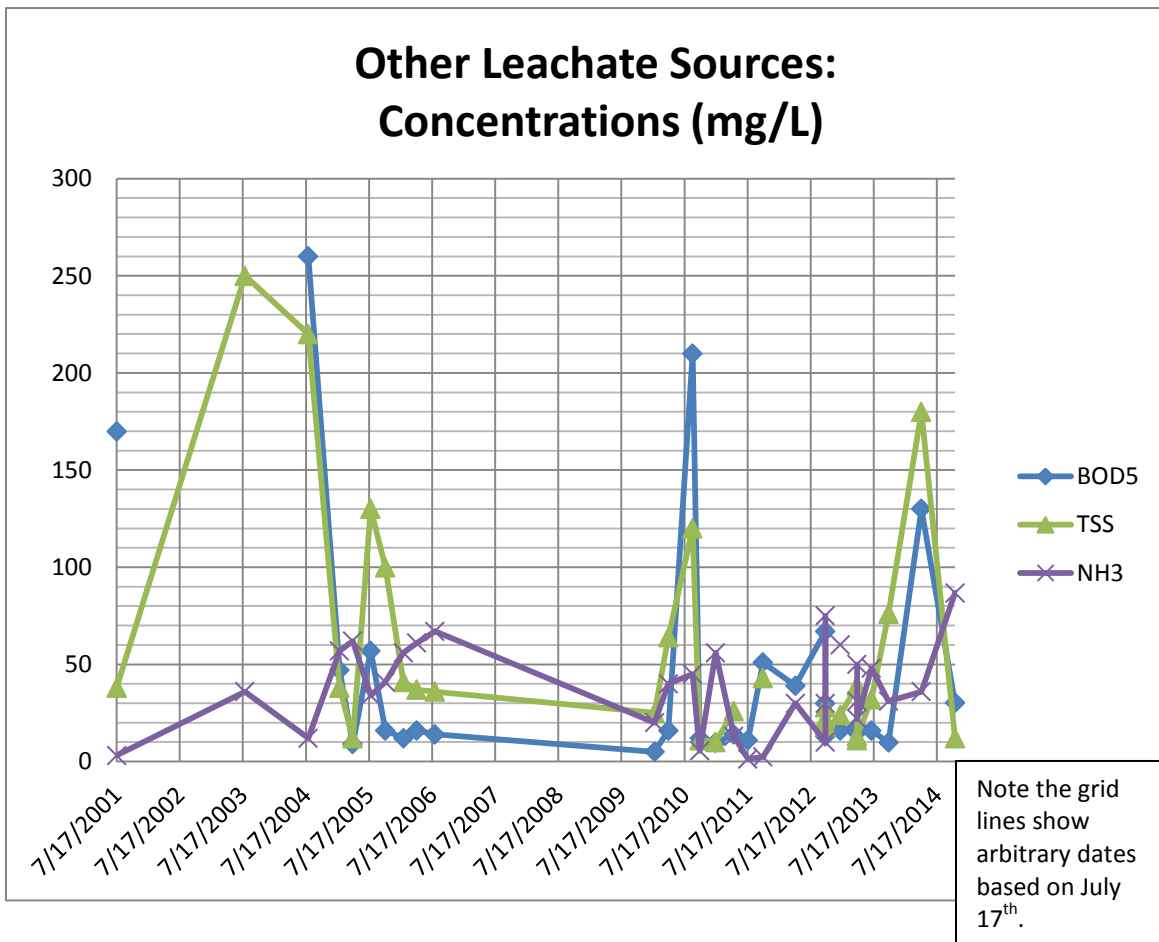
Table 4 and Figure 3 data consist of leachate results for Phases I and II, Cells 1A and 1B, and SEB No. 1 taken by four different samplers: B&M, BWM, Schwab Eaton and AEI. Figure 3 (COD and pH data are omitted) reveals the erratic nature of the data reflecting the different sampling protocols. Table 4 data could represent the first (2010 to 2014) of the three five year periods for each of the parameters for all of the preceding leachate sources. It is assumed that Table 4 data represents the leachate quality for inactive Phases I and II, during the first period if the next two five year periods are based on samples taken only from the Phase's wet well and the three five year results are statistically compatible. The basis for this assumption is that the variability from sampling multiple locations is eliminated.

Table 4 – Key Leachate Data for Other Leachate Sources

Sampler	Date	Location	BOD₅ (mg/L)	COD (mg/L)	TSS (mg/L)	NH₃-N (mg/L)	pH
B&M	7-17-01	Phase I	170	340	38	3.1	6.1
B&M	12-17-02	Phases I & II	NA	20	NA	9.1	NA
B&M	7-29-03*	Phases I & II	1,400	2,200	250	36	6.7
B&M	7-30-04*	Phases I & II	260	500	220	12	6.5
B&M	1-27-05	Phases I & II	47	310	38	57	7.5
B&M	4-13-05	Phases I & II	9	210	12	62	7.6
B&M	7-26-05	Phases I & II	57	1.6	130	34	6.6
B&M	10-19-05	Phases I & II	16	140	100	41	6.7
B&M	2-1-06	Phases I & II	12	270	41	56	6.9
B&M	4-19-06	Phases I & II	16	160	37	61	6.9
B&M	8-2-06	Phases I & II	14	200	36	67	7.6
B&M	1-25-10	SEB No. 1	5	59	25	20	7.3
B&M	4-14-10	SEB No. 1	16	100	64	40	7.6
B&M	9-1-10	SEB No. 1	210	300	120	45	6.8
B&M	10-13-10	SEB No. 1	12	28	11	5.5	7.9
B&M	1-13-11	SEB No. 1	9.6	190	10	56	7.1
B&M	4-28-11	SEB No. 1	14	110	26	13	7.7
B&M	7-19-11	SEB No. 1	11	180	500	1.3	8.5
B&M	10-14-11	SEB No. 1	51	220	43	2.4	8.5
B&M	4-19-12	SEB No. 1	39	410	1,100	30	8
B&M	10-9-12	SEB No. 1	67	370	18	10	8.4
BWM	10-9-12	SEB No. 1	30	370	19	30	8.5
BWM	10-9-12	Phases I & II	13	190	28	75	7.3
BWM	10-9-12	Cell 1A	16	370	22	180	7.2
BWM	1-3-13	Cell 1A	NA	8.8	470	60	7.6
BWM	1-3-13	Phases I & II	16	250	24	NA	7.7
BWM	4-10-13	Phases I & II	17	110	39	50	7.5
BWM	4-10-13	SEB No. 1	18	160	11	31	8.1
B&M	4-10-13	SEB No. 1	15	150	13	22	8.0
BWM	7-3-13	Phases I & II	16	140	32	48	6.8
B&M	10-10-13	SEB No. 1	9.8	130	76	31	8.0
SE(B&M)	4-18-14	Composite of Phases I & II and Cells 1A & 1B	130	160	180	36	7.0
AEI	10-30-14	Same as above	30.2	142	12.0	86.8	6.6
		Average	89	258	117	41	7.4
		Ave. w/o outliers	43	191	52	35	No outliers
		Range	5 to 1,400	1.6 to 2,200	10 to 1,100	1.3 to 180	6.1 to 8.5
		Range w/o outliers	5 to 260	1.6 to 500	10 to 250	1.3 to 86.8	No outliers

*Seven sets of BOD₅ and TSS data collected during the 2003-04 time period were not used. They were part of a B&M report to the Bureau of Water concerning ACL leachate disposal in the LaHarpe POTW. They were not used because companion stabilization data were not available.

Figure 3



Inspection of the bottom part of Table 4 and Figure 3 suggests that the elimination of outliers will also improve the possibility of having the first five year period compatible with the next two periods. Application of the Kendall Tau method to these data could indicate that equilibrium has been obtained for all leachate parameters although it is not recommended for ammonia and pH because they are parameters that should be tracked over time to see if potential increases for ammonia and any change in pH indicated inhibition of bioactivity due to extreme pH levels.

2. Pre-Subtitle D LFG Trends

Compilation of LFG data for the pre-Subtitle D closed site is a more of a challenge because samples are taken monthly for 16 wells, 2 horizontal wells (one well was abandoned in 2012 as part of B&M's landfill GCCS improvement project) and one flare (see Figure 4). This means that for eight LFG measurements, there is about $18 \times 5 \times 12 \times 8$ or 8,640 data. Table 5 and Figure 5 shows Well No. 10 (see Figure 4) data for the period 1-17-10 to 8-2-12 (period of available data to the author at the time of this writing). Well No. 10 is on the southern edge of pre-Subtitle D landfill adjacent to the flare. The velocity and rate values are based on meter readings taken prior to the flare. All other measurements are taken at Well No. 10.

Figure 4 - ACRL Pre-Subtitle D LFG Well No. 10, Blower and Flare Locations (10)

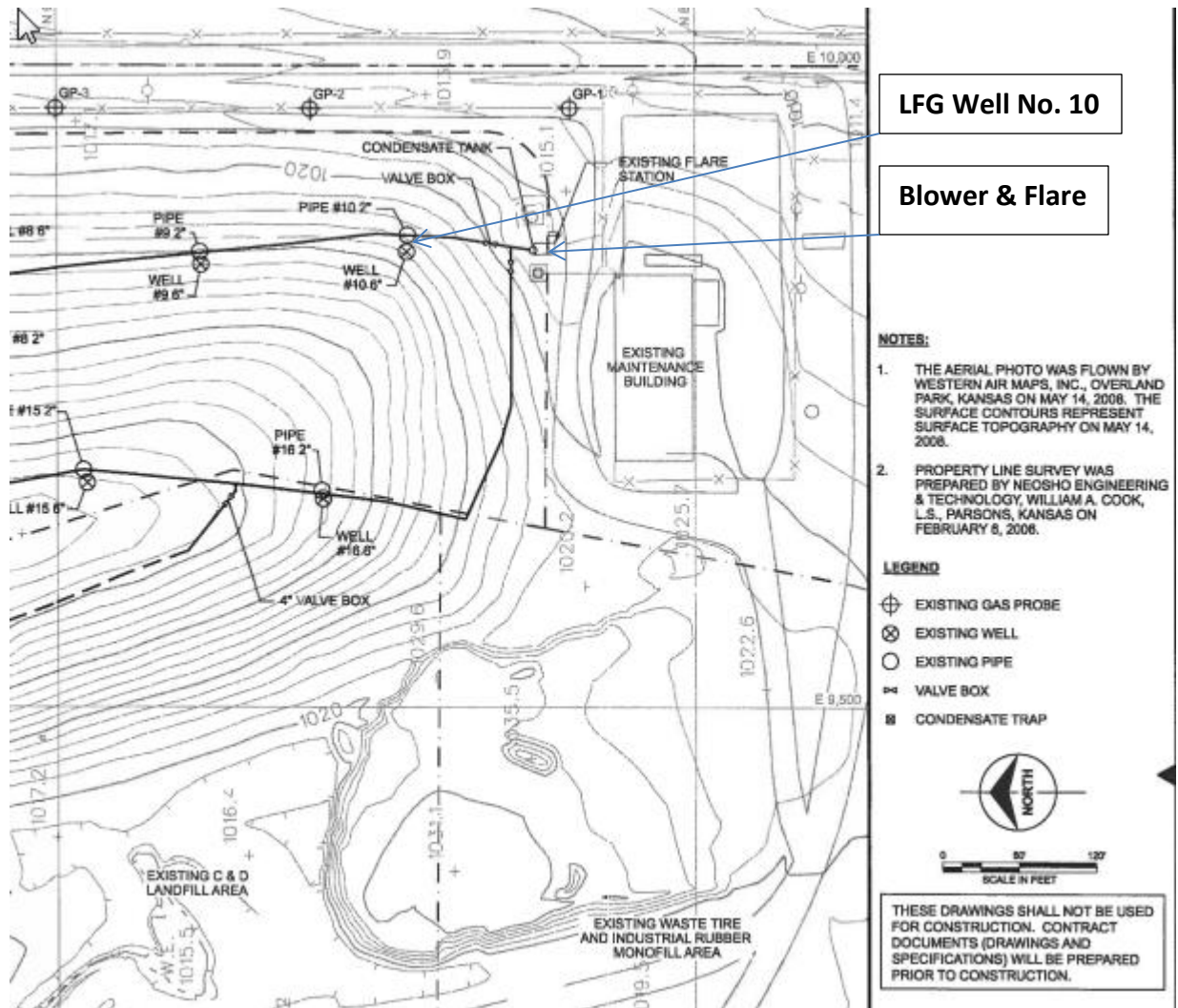
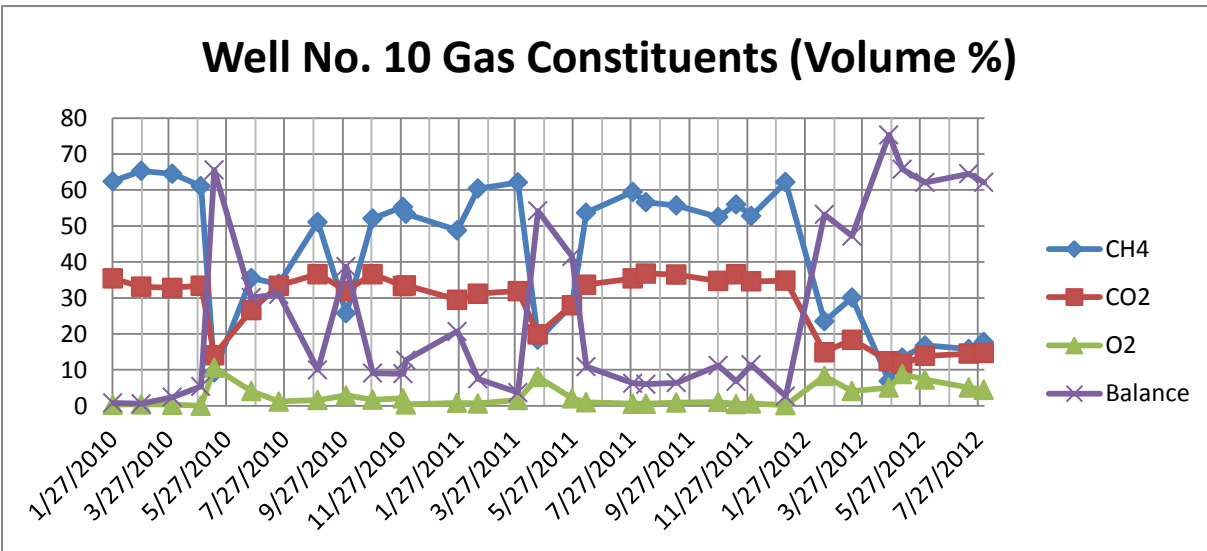


Table 5 – ACRL Pre-Subtitle D Area Blower and LFG Well No. 10 Data

Date	Blower Data		Well 10 Temperature and Composition						
	Velocity (fpm)	Rate (cfpm)	Temperature (°F)	Vacuum (in H ₂ O)	CH ₄ Vol. (%)	CO ₂ Vol. (%)	O ₂ Vol. (%)	Balance (Vol. %)	Sum of LFGs (%)
1-27-10	915	60	46.8	Negative	62.4	35.4	0.3	0.8	98.9
2-26-10	NA	NA	79.5	Negative	65.3	33.1	0.4	0.6	99.4
3-31-10	1,208	98	88.1	Negative	64.5	32.8	0.3	2.4	100
4-30-10	1,409	110	78.0	Negative	61.1	33.4	0.0	5.4	99.9
5-14-10	1,222	100	58.6	0.6	9.3	14.1	10.6	65.6	99.6
6-22-10	1,040	95	98	1.2	35.5	26.6	4.1	30.1	96.3
7-21-10	1,290	100	103.4	0.4	33.9	33.4	1.2	31.0	99.5
8-31-10	1,074	90	80.0	0.1	51.1	36.6	1.6	10.0	99.3
9-30-10	930	65	69.0	0.7	25.7	32.0	2.9	38.7	99.3
10-28-10	1,286	100	63.3	Negative	52.1	36.6	1.7	9.1	99.5
11-29-10	1,099	90	60.2	0.2	55.3	33.3	2.1	8.9	99.6
12-2-10	1,244	90	83.8	Negative	53.4	33.5	0.4	12.7	100
1-25-11	1,439	95	67.8	Negative	48.8	29.5	0.8	20.7	99.8
2-16-11	1,277	95	56.6	Negative	60.4	31.2	0.7	7.5	99.8
3-30-11	1,133	100	53.9	Negative	62.1	31.9	1.6	3.7	99.3
4-20-11	1,353	110	57.5	0.9	18.4	19.9	8.0	54.2	100.5
5-26-11	750	60	75.7	0.7	28.0	28.0	2.1	41.5	99.6
6-10-11	NA	NA	82.2	0.1	53.7	33.7	1.0	10.9	99.3
7-29-11	800	45	101.5	0.3	59.5	35.4	0.6	6.3	101.8
8-12-11	775	65	93.7	0	56.6	36.8	0.6	6.0	100
9-13-11	854	70	118.7	0	55.7	36.5	0.9	6.4	99.5
10-27-11	854	55	57.7	0.1	52.5	34.7	1.1	11.2	99.5
11-15-11	805	52	91.7	Negative	56.0	36.6	0.5	6.8	99.9
12-1-11	800	50	67.4	0.2	52.8	34.6	0.7	11.4	99.5
1-6-12	1,105	NA	75.5	Negative	62.2	34.8	0.2	2.7	99.9
2-16-12	1,530	120	73.9	1.3	23.5	14.9	8.3	53.2	99.9
3-16-12	1,216	100	74.6	0.7	30.1	18.4	4.1	47.2	99.8
4-24-12	1,152	95	72.5	0.2	6.9	12.4	5.1	75.3	99.7
5-8-12	1,533	110	91.4	0.8	13.4	11.7	8.8	65.8	99.7
6-1-12	1,215	110	77.9	0.7	16.8	13.9	7.3	62.1	100.1
7-17-12	1,200	NA	92.6	0.3	15.8	14.5	5.1	64.5	99.9
8-2-12	1,245	110	91.2	0.5	17.7	14.7	4.5	62.1	99

Figure 5



It is apparent that there is a drop off in MSW stabilization since both methane and carbon dioxide concentrations are reduced in the zone of influence of Well No. 10 beginning in February 2012. This trend doesn't exist for the other wells (which would be expected) since different parts of the site receive more moisture than others; hence, the reduction in monitoring activities for LFG wells would have to be determined for each well. Figure 1 (or Figure 1.4) does not provide information about the time required for the slopes of the methane and carbon dioxide curves to reach their peaks and to gradually decline. Therefore, it is necessary to track each well to confirm that it has reached equilibrium.

Note 15: It should be realized that the curves in Figure 1 are based on batch laboratory studies of simulated landfill cells; hence, they provide suggested trends only for the conditions which they represent. The citation for Figure 1 is actually based on a report by Pohland and Harper dated 1987 (10), not 1986 as cited by Reference 7.

Note 16: For sake of example and to minimize the processing of limited data, it is assumed that all the other wells, besides Well 10, are candidates for reduction and/or termination beginning in three five year periods starting in February 2012. However, other wells will have to be tracked to demonstrate they have reached the equilibrium requirements. Once they have reached equilibrium, then withdrawal from the well can be reduced and gas sampling can be reduced or terminated.

Note 17: An alternate, but less desirable, approach would be to begin collecting a composite sample for the pre-Subtitle D part of the landfill before it enters the flare. This would allow a type of composite view of the overall MSW stabilization process along with the total flow measurements currently being made at that location. This emission trend approach is somewhat like that used for tracking leachate changes in Phases I and II since the leachate collected in the wet well is for the entire MSW mass in Phases I and II.

Conclusions

Existing monitoring data and assumed future trends suggest that it is likely that leachate monitoring activities (BOD₅, COD and TSS) can be terminated for pre-Subtitle D toe drain by 2017; also, the monitoring of existing LFG wells. However, as subsequent units are equipped with GCCSs, then additional LFG monitoring will be required. Groundwater monitoring will continue in all existing and

future wells for the landfill's life, but at a decreasing intensity during its post closure care period. In general, groundwater wells will be plugged and abandoned if they are in the future landfill disposal footprints.

Recommendations

There are two aspects of the preceding conclusions which need to be considered. First, all monitoring activities will continue so that the suggested trends can be established and validated statistically by the designated year. Secondly, cost estimate calculations for financial assurance (FA) requirements should be made using the selected reduction and/or termination of activities (monitoring and related activities). The reduced amount of FA required will serve as the basis for the preparation of an **ACRL Report**.

Note 18: *All existing Subtitle D landfills can adapt this prototype **ACRL Report** approach or they can continue to use the plan given in their current FOP or a separate postclosure plan. It is believed that the redoing of either into a postclosure plan with the potential benefit of terminating PCC earlier than the 30 plus year requirements will result in cost savings that will justify the preparation of a similar report.*

Financial Assurance Considerations

The ACRL FA for closure, postclosure or corrective actions costs is provided by the local government financial test. Private landfills that own their own land can use any FA method. Landfills that do not own their land must meet their FA obligations by a purchased financial instrument, i.e., a trust fund, surety bond, irrevocable letter of credit and/or an insurance policy. Significant savings can be realized in FA costs when postclosure unit or landfill activities can be reduced or terminated as soon as possible after closure. This lowers the FA cost estimates by reducing the rolling 30 costs to lesser durations. A hypothetical example using ACRL PCC FA cost data is given in the following paragraphs.

Reference 11 is the PCC cost estimate that was submitted with the ACRL's 2014 permit renewal. Note that it only presents post-closure costs that would be incurred if the ACRL closed during the 2014-2015 permit year and does not include post-closure costs associated with future phases. Also, the costs presented are third party costs, while some of the items (e.g., gas monitoring) are currently performed by ACRL employees. For the purposes of this discussion it is assumed the costs presented are approximately the costs to ACRL. An examination of the estimated 30 year PCC ACRL FA costs presented in Reference 11 (and summarized in the 2014 column of Table 6) shows that less than 12 percent of the annual post-closure costs are due to the leachate (LCCS) and gas (GCCS) collection and control systems. The LCCS O&M costs will not be affected because **Subpart WWW** requires that the LCCS system be operated until the landfill (defined as the total disposal area) has ceased receiving waste and a closure report submitted; and it has been verified by three successive tests dated at least 90 days apart that the landfill is emitting less than 50 Mg NMOC per year. To terminate LCCS operations it is also required that the LCCS has been in operation for at least 15 years. This is a requirement easily met due to the ACRL's long projected life.

The ACRL has 12 property line gas monitoring probes which the PCC worksheet's Lines 7.0.2 plus 7.03 indicate cost \$2,800 annually to physically monitor, with Line 7.0.4 indicating about \$1,600 is required for bookkeeping, adding to annual total cost of \$4,400. Eleven of the 12 probes monitor property line that is only in proximity to the pre-Subtitle D cell indicating that physical monitoring costs can be reduced by approximately eleven-twelfths to about \$233 annually. Bookkeeping costs do not necessarily reduce proportionate to probe count, so these costs are reduced by three quarters to an

estimated \$400 annually. Thus, estimated gas monitoring expenses presented on the post-closure care worksheet can be reduced from \$4,400 to annually to about \$633 annually, a \$3,766 reduction.

Because the pre-Subtitle D cell toe drain operates by gravity drainage, the primary expense reduction incurred by pre-Subtitle D area waste stabilization would be a reduction in sample collection and analyses (Reference 11's Lines 5.0.7 and 5.0.8). Subsequent to Reference 11's preparation, and as presented in this paper, leachate sampling at the ACRL has been revised to collect and analyze samples from three unique locations and line 5.0.8 should present six, not two analyses, increasing Line 5.0.9's annual leachate system total costs from \$8,330.20 to \$12,762.20. Assuming that eliminating toe drain sampling has only a slight effect on sample collection costs, sampling from three locations twice per year would result in six analyses per year, an addition of four analyses, increasing Line 5.0.9's annual leachate system total costs from \$8,330.20 to \$12,762.20. Thus, the analyses costs reduction is based going from six to four analyses per year (\$6,648 to \$4,432 per year), a reduction of \$2,216 per year.

The table below, based on data from ACRL's 2014 permit renewal, presents the potential reduction in PCC FA that can be achieved by the reduced monitoring requirements described above, and possible operational savings that that can be achieved by reduced monitoring requirements when the unit is in PCC.

Table 6 – Example Projected PCC Annual Costs for FA Purposes

Closure Cost Estimate Year	2014*	Adjusted 2014
Affected Units	All units	Reduced pre-Subtitle D Monitoring Costs
Annual Costs	\$152,516	\$144,738
Annual Savings	-	\$7,778
30 Year Costs	\$4,575,471	\$4,342,134
30 Year Savings		\$233,337

* See Appendix 4 which is an extract from ACL's 2014 Permit Renewal (11).

Postscript

Much of what is presented in this document is based on data that were not collected for the designated purpose of this document, i.e., preparing an **ACRL Report** (4). This was pointed out with regard to leachate and LFG sampling results. Guidance is available to produce the best results for both emissions (12, 13). Also, companion data, e.g., flow data with date coordinated sampling values, must be collected if emission analysis results are to have their greatest value (4). As stated previously, such data were not collected since that collection was not required by regulations or by an approved FOP, closure plan, postclosure plan or **ACRL Plan** (PCC plan); and was extraneous (not required data collection at that time). Also, if more reliable flow data had been recorded, then more definitive conclusions could have been reached by this **ACRL Report**.

BWM Solid waste Permit Section engineers have been equipped to assist landfill O/O in perfecting their sampling and other data collection skills so that a comprehensive **ACRL Report** can be prepared. It is imperative that O/O (with available supporting personnel: consultants and/or laboratory samplers) utilize BWM resources cited in this document if a proposed **ACRL Report** is to receive BWM approval.

References

1. For BWM: <http://www.kdheks.gov/waste/index.html> and for BOA: <http://www.kdheks.gov/bar/index.html>
2. **Reduction and/or Termination of Postclosure Care Activities**, BWM Policy 2014-P2 (5-2-14).
3. **Proposed Modifications for ACRL Facility Operating Plan** (3-4-15).
4. **Preparation of Postclosure Care Reduction and/or Terminations Plans**, BWM Technical Guidance Document SW-2014-G1 (5-2-14).
5. **Operating Plan for Allen County, Kansas Municipal Solid Waste Landfill and Waste Tire and Industrial Rubber Landfill**, by Burns and McDonnell, Project Number 50801, KDHE Solid Waste Permit #101 (Revised August 2011).
6. **Solid Wastes: Engineering Principles and Management Issues** by G. Tchobanoglous, H. Theisen and R. Eliassen, McGraw-Hill, Inc., New York (1977).
7. **Characterization, Design, Construction, and Monitoring of Bioreactor Landfills**, by Interstate Technology & Regulatory Council (February 2006).
8. **PCC Statistics for Leachate Trend Analysis: Kendall's Tau**, by Carl E. Burkhead (11-5-14). Also, see BWM Presentations Website: SWANA/KDHE Solid Waste Management Conference and Operator Training Course, Manhattan (November 19-20, 2014) http://www.kdheks.gov/waste/p_workshops.html
9. **Allen County, Kansas: Landfill Gas Improvement/Expansion**, Burns & McDonnell, Drawing No. C002 (July 2009).
10. **Retrospective evaluation of the effects of selected industrial wastes on municipal solids waste stabilization in simulated landfills**, by Fredrick G. Pohland and Stephen R. Harper, USEPA, Hazardous Waste Engineering Research Library (1987).
11. **Landfill Post-Closure Care – 2014 Annual Cost Estimate Worksheet, Permit No 0101**, by Chris Snider, Burns & McDonnell (May 28, 2014).
12. **Leachate Sampling for Reduction and Termination of Postclosure Care**, BWM Technical Guidance Document, SW-2013-G3 (5-2-2014). See: <http://www.kdheks.gov/waste/techguide/SW-2013-G3.pdf>
13. **Landfill Gas Sampling for Reduction and/or Termination of Postclosure Care**, Technical Guidance Document SW-2014-G2 (5-2-2014). See: <http://www.kdheks.gov/waste/techguide/SW-2014-G2.pdf>
14. **Permit modification Horizontal & Vertical Expansion Allen County Sanitary Landfill, Allen County, Kansas 37214** by Burns and McDonnell (August 2008).

Appendix 1 – Existing Closure and Postclosure Plans

The following 4.0 and 5.0 pdf extracts (Click on the extract to identify the pdf portions of the text. The discontinuities are a result of copying and pasting the pdf documents.) were taken from the August 2008 **Permit Modification to the Horizontal and Vertical Expansion for the ACL (14)**. They represent respectively the current Closure and Postclosure Plans for the ACRL.

4.0 CLOSURE PLAN

This closure plans applies to the existing Subtitle-D Phases I and II and the new proposed MSW landfill expansion. A completed closure worksheet for the expanded landfill has been included in Appendix I of this report.

4.1 NOTIFICATION OF CLOSURE

The Allen County Landfill will be closed when filling operations are completed. KDHE will be notified at least 60 days before last receipt of waste. Waste acceptance will cease when the waste elevations are approximately 32 inches below final elevations presented in the design drawings.

4.2 FINAL COVER

The final cover system will consist of a minimum 18-inch compacted soil liner with a hydraulic conductivity less than or equal to 1×10^{-5} cm/sec. This layer will be overlain by a 40-mil HDPE FML. A double sided geocomposite (geonet and geotextile) will serve as a drainage layer over the FML. The geocomposite will be overlain with a 14-inch layer of nominally compacted soil for frost protection. The uppermost layer of the final cover system will consist of a minimum of six inches of topsoil capable of supporting vegetation. The type of vegetation will be a mixture of native grasses. All areas affected by final cover construction (including the landfill itself, borrow areas, etc.) will be graded to drain and seeded accordingly. The final cover of the landfill will be constructed with a 3:1 horizontal to vertical slope. The minimum slope of the final cover will be 5% to allow for drainage. The final cover of the landfill will be sloped to drain and graded to blend into the surrounding natural ground surface. Erosion control will be provided by diversion berms and the vegetation planted after closure. Intermediate erosion control will be provided by overlaying the soil cover with straw if the soil cannot be seeded due to seasonal weather.

The landfill cover will be graded such that precipitation that falls on the landfill will be directed to reinforced let-down channels that drain the water off the side slopes of the landfill. The let-down channels drain into the perimeter channel which routes the water to the sedimentation pond south of the landfill.

The largest area requiring final cover will occur when the landfill is completed. The total area to be covered includes the eight expansion cells as well as the overlap areas above the previously permitted Subtitle-D areas and the industrial waste landfill. The maximum area requiring a Subtitle-D final cover will be approximately 2,522,100 ft², or 58 acres. Upon closure, approximately 5,523,900 cubic yards, or 3,038,200 tons of MSW will be placed in the landfill expansion and overlap areas.

After the final cover construction is completed and quarry activities have ended, the main access gate will be locked and public access to the site will not be allowed.

4.3 SCHEDULE

The closure plan of the landfill will be completed according to the following schedule:

- Notify KDHE in writing at least 60 days before closure.
- Begin implementation of the closure plan within 30 days after the date on which the site last receives waste.
- Complete closure activities in accordance with the closure plan within 180 days after the last receipt of waste at the site.
- Provide KDHE with closure certification verifying that landfill closure has been completed in accordance with this plan. Certification shall be signed by an independent registered professional engineer.

4.4 FINANCIAL ASSURANCE

Allen County Sanitary Landfill currently uses a trust fund as their form of financial assurance for landfill closure. A copy of an updated closure cost estimate worksheet that incorporates the proposed expansion is included in Appendix I. The updated cost estimate includes expenses for the closure of the proposed Cell 1A/B and existing Phases I and II. When Cell 2 is constructed, it will be incorporated into the area used to calculate the closure cost estimate. The Allen County landfill financial assurance documentation, including a certificate of liability insurance, can also be found in Appendix I.

5.0 POST-CLOSURE PLAN

5.1 INTRODUCTION

The purpose of post-closure assurance for landfills is to assure that sufficient funds are available to properly maintain and monitor a landfill during the post-closure period. Proper maintenance and monitoring includes maintaining the integrity of the final cover, operating and maintaining the leachate management system, and sampling and testing groundwater monitoring wells, gas monitoring wells, and surface water discharges.

5.2 POST-CLOSURE CARE

Allen County will be responsible for post-closure care at the site for 30 years after closure of the landfill. A completed post-closure financial worksheet has been included in Appendix I of this report. A system of perimeter stormwater berms and channels constructed during the various phases of landfill development will prevent run-on from the surrounding area. The final cover will be inspected annually and anytime following a major rainfall event (4 or more inches in 24 hours). Maintenance will consist of recontouring the site with proper earth-moving equipment and seeding as necessary following occurrences of settlement, erosion, etc. Other site characteristics such as channels, berms, ponds, and access roads shall be inspected annually and maintained as required. All inspections shall be documented. After vegetation is established on the final cover, the landfill area will be utilized as greenspace. No post-closure use of the property shall disturb the integrity of the landfill cover unless justification is submitted to and approved by KDHE.

Groundwater and gas monitoring is required during the entire post-closure period. The groundwater system will be sampled semi-annually. However, Allen County may petition KDHE for less frequent sampling events (annually at a minimum). The landfill gas system will continue to be monitored at least quarterly throughout the post-closure period. All gas and groundwater wells shall be inspected at least annually to ensure any damage due to settlement or other means is repaired. Any questions that arise about the site during the post-closure period should be directed to:

Groundwater and gas monitoring is required during the entire post-closure period. The groundwater system will be sampled semi-annually. However, Allen County may petition KDHE for less frequent sampling events (annually at a minimum). The landfill gas system will continue to be monitored at least quarterly throughout the post-closure period. All gas and groundwater wells shall be inspected at least annually to ensure any damage due to settlement or other means is repaired. Any questions that arise about the site during the post-closure period should be directed to:

Allen County Board of Commissioners
1 N Washington
Iola, Kansas 66749
(620) 365-1406

Appendix 2 – Chronology of ACL Leachate Generation and Storage Facilities

Date	Activity	Area** (acres)
November 1974	Use of the site for a landfill approved by BWM with conditions limiting the types wastes disposed & requiring that the landfill will file to obtain a permit in 1975 when permits become required.	
March 1976	Pre-Subtitle D landfill permit issued.	12.5
?	Waste tire monofill** opened (no leachate collected from here).	5.92
1994 - 1997	16 Groundwater monitoring wells installed.	
February 2001	Phase I** disposal initiated & leachate tank in service. Phase I was constructed in the spring & summer of 1996, but not initially used. Intermittent disposal into the pre-Subtitle D cell continued to help blend the cells' contours until October 9, 2001 when the pre-Subtitle D cell's vertical expansion exemption expired.	4.48
Summer 2002	16 Gas extraction wells were installed in the Pre-Subtitle D area concurrent that area receiving final cover and Phase II's construction.	
October 24, 2002	Leachate haul record begins (confirmed by Rod Geisler's letter dated March 14, 2005.	
November 2002	Phase I disposal ends & Phase II** starts with leachates from both phases commingled.	8.45
December 2002	RWD No. 8 water application to active site except when recirculating leachate (see next listing) or on significant rainfall events.	
May 7, 2004	Leachate recirculation initiated (see Haul record).	
2005	ACL permitted to recirculate leachate to active face up to 10,000 gpd.	
December 2007	Waste placement begins in C&D landfill** . The C&D landfill is not tied into the leachate collection system.	5.72
February 2010	Phase II MSW disposal ceases & leachate tank is taken out of service; Cell 1A** MSW disposal initiated & SEB No. 1 in service.	6.00
July 2013	Cell 1B** opened & Cells 1A & 1B leachates commingled. (When Cell 1B's waste elevation is the same as Cell 1A's current elevation, disposal North to South into both cells will continue. This disposal will extend east up the slopes of Phases I & II bringing combined Cells 1A's & 1B's elevations to match Phases I & II . To obtain the designed final cover slopes additional disposal into Phases I & II will occur.	4.54

*The table contents were obtained from various documents where comments were made concerning the subject item's dates. The documents include the following:

1. Scroll of leachate quality record for collected leachate samples (2001 to 2011).
2. Carl Burkhead's e-mail to Eula Hutton dated July 3, 2012.
3. Charley Bower's e-mails to me dated June 19, 2012 & July 25 & 30, 2013; & an undated response to a spreadsheet Carl had sent to Charley.
4. ACL Leachate haul record from October 24, 2002 to June 2013.
5. Brian Weis' e-mail to Carl dated June 27, 2012.
6. B&M's Proposed Allen County MSWLF Expansion report dated March 2006.

**Area refers to initiation or startup of indicated landfill unit.

Appendix 3 – Monthly Toe Drain Volumes (gallons)*

May 2004	June 2004	July 2004	August 2004	September 2004	October 2004	November 2004	December 2004	January 2005
60,500	68,500	76,000	52,500	30,000	77,000	77,000	56,000	46,000
February 2005	March 2005	April 2005	May 2005	June 2005	July 2005	August 2005	September 2005	October 2005
12,000	29,000	2,000	4,000	12,000	8,000	18,000	2,000	4,000
November 2005	December 2005	January 2006	February 2006	March 2006 to April 2012	May 2012	June 2012	July to August 2012	September 2012
13,000	No data	No data	8,000	No data	8,000	46,000	No data	500
November 2012	December 2012	January 2013	February 2013	March 2013	April 2013	May 2013	June 2013	July 2013 to date
4,800	26,400	17,600	16,800	25,950	10,700	16,800	12,800	No data

***Note:** October 2012 was inadvertently left out of the table but there was no reported volume.

[illegible]

26

Landfill Post-Closure Care - 2014 Annual Cost Estimate Worksheet					Permit No.: 0101	
ITEM NO.	FROM	QUANTITY	UNITS	LUMP COST	COST	SUBTOTALS
7.0.0	GAS MONITORING SYSTEM O&M					
7.0.1	Number of Gas Monitoring Probes/Arms - 32					
7.0.2	Address monitoring of probes (each) (1 per year)	4	Direct	\$500.00	\$1,400.00	Burns & McDonnell estimated cost for sampling this site
7.0.3	Methane monitoring at site boundaries and structures (1 per year)	4	Direct	\$650.00	\$2,600.00	Burns & McDonnell estimated cost for sampling this site
7.0.4	Sample analysis and reporting	4	Direct	\$600.00	\$1,800.00	Burns & McDonnell estimated cost for analysis and reporting for this site
7.0.5	Gas Monitoring System O&M Annual Subtotal				\$4,800.00	
8.0.0	GAS EXTRACTION SYSTEM O&M					
8.0.1	Con vents, 24 vents, 30' average depth					
8.0.2	Pulsing System					
8.0.3	Positive well head for line maintenance		EACH		\$0.00	NA
8.0.4	Relief System					
8.0.5	Flare, 10.5 (WABU) four phase	1	EACH	\$1,500.00	\$1,500.00	Burns & McDonnell estimated annual allowance for flare operation
8.0.6	Additional Well Ventilation Upgrades		EACH		\$0.00	NA
8.0.7	Arc flash gas separator repair (break contract, opening, 6 weeks, two-phase collection)	1	Lump Sum	\$10,000.00	\$10,000.00	Placeholder to replace Flare #14 at 15 years. Burns & McDonnell estimate based on actual price from 2012 project.
8.0.8	Gas Extraction System O&M Annual Subtotal					\$11,500.00
9.0.0	CORRECTIVE ACTION EVALUATION AND IMPLEMENTATION					
9.0.1	Review in response to reference points and the benchmarks (prepare for annual program)		EACH		\$0.00	NA
9.0.2	Revised treatments from stormwater basins (prepare for annual expansion)	0.1	EACH	\$88,000.00	\$8,800.00	2014 MS March Site Work Cost Data Book
9.0.3	Stormwater treatment facilities evaluation		EACH		\$0.00	NA
9.0.4	Groundwater alternate source determination (prepare for annual expansion)		EACH		\$0.00	NA
9.0.5	Other		Lump Sum		\$0.00	NA
9.0.6	Corrective Action Evaluation and Implementation Annual Subtotal					\$8,800.00
10.0.0	POST-CLOSURE CARE ANNUAL COST SUBTOTAL					\$111,800.00
11.0.0	Administrative Services (Post-Closure Care Subtotal (10.0.0) x 0.01)				\$6,778.00	Cost published unit
12.0.0	Contaminant Post-Closure Care Subtotal (10.0.0) x 0.01				\$11,180.00	Cost published unit
13.0.0	PROFESSIONAL SERVICES (Post-Closure Care Subtotal (10.0.0) x 7%) OR Other costs provided by third party with license listed in Item below				\$7,826.00	Cost published unit
14.0.0	Engineering (annual inspection and reporting, corrective action design and bid, contract management)		Lump Sum		\$7,826.00	Cost published unit
15.0.0	Topographic and Boundary Survey		Lump Sum		\$0.00	NA
16.0.0	Corrective Action Engineering Services (construction oversight, testing, reporting, construction)		Lump Sum		\$0.00	NA
17.0.0	Total of Line Items 11.0.0 through 16.0.0		Lump Sum		\$0.00	NA
18.0.0	TOTAL ESTIMATED ANNUAL POST-CLOSURE CARE COST					\$148,410.00
ESTIMATED 30 YEAR POST-CLOSURE CARE COST						\$4,402,830.00

Estimator: Christopher J. Snider, P.E.
(Printed Name)
Date: 5/28/2014
Signature: [Handwritten Signature]

Appendix 5 – Note Free Version of the ACRL Report

Proposed Allen County Regional Landfill (ACRL) Postclosure Care (PCC) Reduction and/or Termination Report (7-16-15)

Introduction

The objective of this proposal is to present the current ACRL Closure and Postclosure Plans (see Appendix I) along with existing monitoring requirements; and to present the **ACRL Report** which will enable the ACRL to reduce and/or terminate certain PCC activities for the purpose of reducing costs without compromising health or safety or the environment. The **ACRL Report** will define what changes are actually being proposed and why. It is based on actual but limited data and, in some cases, assumptions, so that different aspects of activity reduction and/or termination can be demonstrated.

Strategy for the Preparation of an ACRL Report

The existing Closure and Postclosure Plans in Appendix I and the following section describe and define the existing monitoring requirements corresponding to the current plans. The monitoring requirements offer financial incentives for the preparation of the **ACRL Report**. Other related cost savings are possible in the areas of: security, regulatory, hydrology, weather, surface maintenance, settlements and seeps, public concerns, land use and financial assurance. An example for surface maintenance would be the reduction in final cover care due to the stabilization of the stored MSW and, hence, the cessation of surface subsidence which would help minimize the final cover maintenance and placement needs.

Existing Monitoring Activities

Monitoring activities are required by Bureau of Waste Management (BWM) and Bureau of Air (BOA) regulations. They were performed in the past by Burns & McDonnell (B&M) and are currently being conducted by ACRL consultants: Schwab Eaton and AEI. Table 1 (at the conclusion of this section) summarizes these activities. Emission considerations for fugitive sources like haul roads and the fuel storage tank are not included in Table 1 since they are estimated from generic data sources.

Groundwater Monitoring [KAR 28-29-113(a) and (b)]

Subpart (a) deals with detection monitoring and subpart (b) deals with assessment monitoring requirements. The latter requirement is initiated if there is a statistically significant increase in the background concentration for one or more constituents or if the background concentrations have not been established by prior monitoring [see **KAR 28-29-113(b)(1)(A) and (B)**]. BWM staff review the semiannual sampling results to see if the above monitoring requirements are satisfied. To date, there have been no exceedances nor has there been a failure to establish background concentrations.

Based on the January 7, 2013 Burns and McDonnell (5) groundwater monitoring report, there are 19 active shallow wells and 15 active medium depth wells. Monitoring and piezometer wells are located around and within the landfill site. There are no active monitoring wells in the closed, inactive or active MSW disposal sites (pre-Subtitle D and Subtitle D Phases I and II, and Cells 1A and 1B; and C&D and Industrial Waste sites). The earliest wells were installed in 1994 and the latest in 2010. Nine shallow and five medium wells have been plugged and abandoned because of landfill expansions.

Leachate Monitoring [KAR 28-29-104(i)(6)]

Annual leachate sampling of each unit is required [see **KAR 28-29-104(i)(6)(A)**]; however, at the ACRL leachates from inactive Phases I and II are comingled in a gravity fed wet well as are currently inactive Cell 1A and active Cell 1B leachates which comingle in a common sump (as will the A and B portions of future Cells 2 to 4). Also, leachate samples, since the construction of SEB No. 1, have been taken from the surface of the basin near the northeast corner where both leachate streams (Phases I and II, and Cells 1A and 1B) discharge into the SEB. The most recent (do not include additional samples taken up to the date of this report as per **Note 7**) samples of October 30, 2014 were undefined composites of Cells 1A and 1B discharge stream at the retention basin and from the lift station which is comprised of Phases I and II discharges. BWM staff took **quarterly** leachate samples from the Phases I and II, and Cell 1A during 2012 and 2013. Samples of leachate from the closed pre-Subtitle D unit's toe drain are taken from a sump near the sediment pond. Part of this drainage comes from an area which is below Phase II's lined cell (The toe drain section below Phase I is solid pipe.).

Gas Monitoring in Structures and the Facility Boundary [KAR 28-29-108(e)]

Quarterly monitoring is performed to insure that explosive conditions do not develop in structures or at the facility boundary. There are **continuous** gas monitors in the maintenance building and there are 12 gas monitoring probes located along the northern and eastern boundaries of the landfill.

Gas Monitoring of Landfill Gas (LFG) from the Gas Collection and Control System (GCCS) [KAR 28-29-108(h) and Clean Air Act, §60.752(b)(2)(ii)(A)]

The current GCCS was installed by ACRL to prevent off-site LFG migration from the unlined pre-Subtitle D cell subsequent to the cell's capping. The GCCS uses a flare to combust captured LFG and the ACRL has an air emission source Class 1 operating permit issued by the BOA. The permit covers emissions from the landfill, haul road and a diesel storage tank. This postclosure care (PCC) discussion only addresses LFG emissions.

In 2008 the ACRL's MSW approved design capacity was increased by a horizontal and vertical expansion to approximately 6.57 million cubic yards and 3.61 million tons, about 5.03 million cubic meters (m³) and 3.28 million megagrams (Mg), respectively. According to the New Source Performance Standards (NSPS) presented in **KAR 28-19-720 40 CFR Part 60, Subparts A and WWW** the expansion resulted in the ACRL classified as a "new landfill." As a new landfill, because either of the respective cited capacities exceeds the 2.5 million m³ or 2.5 million Mg limits at which NSPS apply, the ACRL is subject to the NSPS. Because of this, the air emission permit requires operating the GCCS in conformance with the NSPS presented in **Subpart WWW**. The currently applicable NSPS requirements consist of annually estimating the ACRL's non-methane organic compound (NMOC) emissions using techniques prescribed by **Subpart WWW**.

Installation of an expanded GCCS control system in areas where waste has been in place greater than five years will be required within 30 months of LFG NMOC emissions exceeding 50 Mg per year.

Monthly pressure measurements are made in the pre-Subtitle D closed landfill at the gas collection header of each individual well [**§60.755(a)(3)**]; also, oxygen and temperature are measured at each well [**§60.755(a)(5)**].

Gas Monitoring of Flare and Surface Emissions

The collected LFG is burned in a flare where site personnel make **weekly** measurements of flow, methane, carbon dioxide, oxygen and other gases. A landfill GCCS chart recorder measures system vacuum; inlet temperature, flow and pressure; and flare temperatures at **10 minute intervals**.

Applicable regulations include **KAR 28-19-650** for flare emission opacity and **KAR 28-19-750 (40 CFR Part 63, Subparts A and AAAA)** for National Emission Standards for Hazardous Air Pollutants (NESHAPs) maximum achievable control technology (MACT) requirements. Flare performance requirements are presented in **40 CFR Part 60.18(c) to (f), and 60.752(b)(2)(iii)(A)**. LFG extraction system performance requirements are presented in **40 CFR 60.752(b)(2)(ii)(A)**. Record keeping requirements related to the flare and LFG extraction are presented in **40 CFR 60.7 and 60.756**.

When the expanded GCCS system is installed, the quarterly surface monitoring required by **40 CFR 60.753(d)** will be initiated. The expanded GCCS will remain in operation until the landfill closes and three consecutive annual NMOC calculations present NMOC emissions less than 50 Mg.

ACRL monitoring activities are presented in Table 1. GCCS monitoring follows Clean Air Act NSPS requirements. Activities that will be required in the future, either due to cell construction or when an expanded GCCS is necessary are presented in italics.

Table 1 – ACRL Monitoring Activities

Monitoring Activity/Bureau monitoring results	Location(s)	Frequency	Parameters
Groundwater/BWM	Multiple monitoring wells	Semi-Annual	KAR Appendix I (Geochemicals & volatile organics for detection monitoring)*
Leachate/BWM	Pre-Subtitle D toe drain sump, Phases I & II wet well, Cells 1A & 1B SEB inlet & SEB No.1 <i>future cells' SEB inlets</i>	Biannually and Quarterly	Flow, KAR Appendix I* (see above), BOD ₅ , TSS, total iron & pH
Landfill gas at wells and flare inlet header/BOA	Multiple wells	Monthly at wells and weekly at flare	CH ₄ , CO ₂ , O ₂ , balance gases, pressure & temperature
Flare emissions/BOA	Flare	Recorded continuously every 10 seconds at flare	System inlet pressure, flow rate, temperature, bypass flow rate, actual exit velocity & average combustion temperature
<i>Surface emissions (two to four inches above the landfill surface/BOA)</i>	<i>Areas with installed LFG extraction wells</i>	<i>Quarterly</i>	<i>CH₄ above background</i>
Boundary emissions/BWM	North & east edge of landfill	Quarterly	CH ₄
Structure emissions/BWM	Maintenance building, office & storage shed	Weekly & Continuous	CH ₄

*See **KAR 28-29-113(c)**.

ACRL Report Considerations

As stated in the TGD SW-2014-G1 (4), the goal of the **ACRL Report** is “to describe the methodology that will be used to:

- Predict a time when certain PCC activities may be terminated (before, at, or after 30 years); and
- Demonstrate that a particular PCC activity may be reduced or terminated without risk to public health or safety or the environment.”

Also, “The proposed trend methodology to determine when one or more PCC activities may be reduced and/or terminated will involve a minimum of 3 major evaluation periods of at least 5 years each where each period is statistically verifiable. The determination of equilibrium for leachate and landfill gas emissions can be accomplished by quarterly sampling over a 5-year demonstration period, during which there is no statistically significant difference in key parameter values with time. If there is a statistically significant difference in any of the key parameters, a new 5-year demonstration period must begin. After 1 demonstration period in which key parameters are shown to be in equilibrium, reduction of appropriate activities may begin, after approval by KDHE. After 3 consecutive demonstration periods in which key parameters are shown to be in equilibrium, appropriate activities may be terminated, after approval by KDHE.”

Appendix 2 gives a chronology of unit changes for the ACRL. This historical review provides key dates for the opening and closing of landfill units that are affected by the preceding reduction and termination criteria. Projected dates for unit activity changes are given in Table 2.

Table 2 - Projected Dates* for Unit Activity Reduction or Termination

Unit	Pre-Subtitle D	Phases I & II	Cells 1A & 1B
Date Closed	October 2001	Anticipated 2028 (Currently Inactive)	Estimated 2050 (Cell 1A inactive, Cell 1B active)
5 Year Period (Reduction)	October 2006	Anticipated 2033	Estimated 2055
15 Year Period (Termination)	October 2016	Anticipated 2043	Estimated 2065

* Based on last unit closed in unit categories.

ACRL Report

The basis for the **ACRL Report** is the latest approved FOP (5) and subsequent approved modifications which might occur after the latest amended FOP. The proposed (assumed approved) modifications are given in Reference 3. TGD SW 2014-G1 (Reference 4) gives General Requirements and Plan Contents for the **ACRL Report**. The following sections of the **ACRL Report** are based on these requirements.

Trend Parameters

The key parameters to judge whether a trend exists which can result in a reduced or eliminated monitoring activities for the pre-Subtitle D toe drain and LFG wells; and for Phases I and II leachate were given in Table 1 in the previous section entitled **Existing Monitoring Activities**. Groundwater, flare, surface fugitive, boundary and structural emissions are considered supplemental parameters because they do not directly reflect the results of the MSW stabilization processes or the duplicate LFG measurements as determined at the individual wells. These other LFG monitoring results are affected by the ameliorating effects of the actual and assumed final cover materials.

3. Leachate Parameters

The key leachate and LFG parameters as shown in Table 1 are by-products of the MSW biostabilization reactions occurring within the landfill mass. They are distinct from the other reactions,

e.g., physical solution of MSW components which are non-biodegradable and the chemical reaction of MSW components reactive with water. The selected leachate parameters represent the response of microorganisms to the biodegradable portion of the MSW but do not reflect the nature of the MSW itself, except to say that it can be used as a food source by the microbes. It should be noted that some of the MSW is not biodegradable.

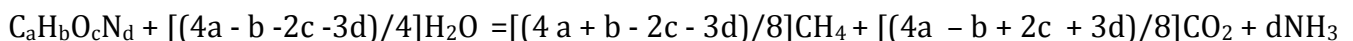
The five day biological oxygen demand (BOD₅) leachate parameter indicates the amount of biodegradable food remaining in the leachate, e.g., the Phases I and II values for quarterly sampling in 2012 to 2013 were 13, 16, 17 and 16 mg/L, which is very small compared to the BOD₅ of MSW. The corresponding chemical oxygen demand (COD) values were 190, 250, 110 and 140 mg/L; also small in comparison to the undigested MSW. COD values include the BOD₅ results and a non-biodegradable portion. Typically, this portion is much larger than the biodegradable portion. The values are more variable than the BOD₅ values but this is not unusual since they reflect a more diverse organic source. Total suspended solids (TSS) represents part of this diversity in that it can include insoluble organics which are COD oxidizable; but more than likely, TSS represents microbial solids washed off the MSW mass into the leachate. Corresponding TSS values for the previously presented quarterly BOD₅ and COD values are 28, 24, 39 and 32 mg/L; which are more consistent than the COD values but less than the BOD₅. The pH values were 7.3, 7.7, 7.5 and 6.8. They represent an acceptable range for the survival of the microbes digesting the MSW. The lower value of 6.8 could be an indicator of a buildup of organic acids which would lower the pH despite the high alkalinity values (984, 954, 865 and 972 mg/L). Alkalinity is a measure of the buffering capacity of the leachate. It represents the ability of the leachate to resist the change in pH due to the addition of an acid. Acids are produced in the stabilization process. They are typically degraded by the methane formers (see subsection 2 below).

The other key leachate parameter is ammonia, NH₃. Values measured were 75, NA (not analyzed), 50 and 48 mg/L. These values indicate that the microbes attached to the MSW mass and released into the leachate had undergone endogenous respiration which results in the loss of NH₃. Although oxidizable in an aerobic environment, NH₃ will build up in an anaerobic or reducing one. It is well known that NH₃ levels will increase as MSW stabilization continues.

The measurement of flow allows the mass flow rate of these key parameters to be determined. This is important since it takes into account the total amount of pollutants in the leachate. Corresponding flow values are not available for these quarterly samples.

4. LFG Parameters

Methane, CO₂ and NH₃ are by-products of MSW anaerobic digestion which occurs as follows (6):



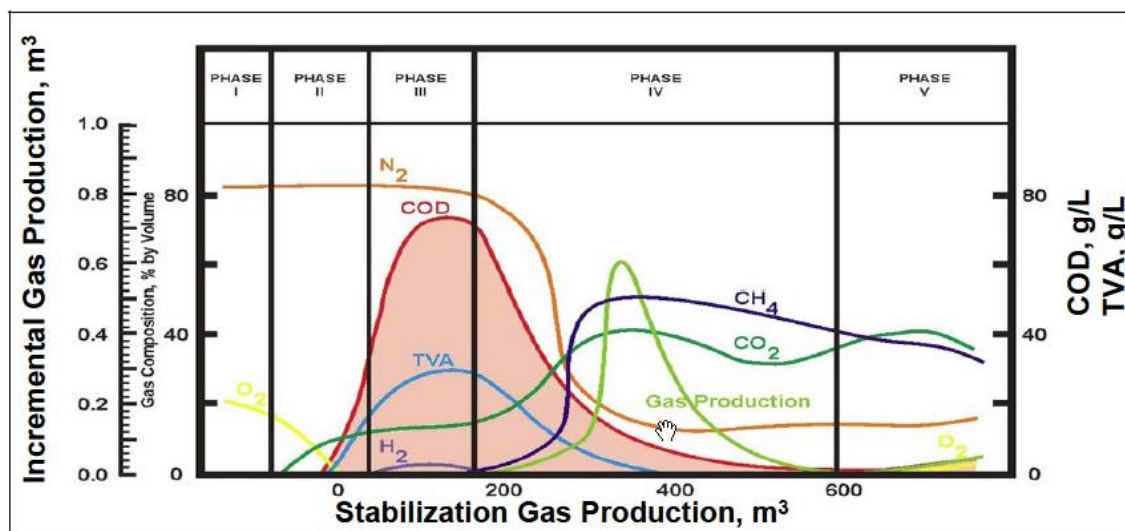
This reaction occurs in two steps; the first step produces organic acids which are then digested in the second step producing CH₄ (also, CO₂ and NH₃). Again, like for leachate, CH₄ production is an indication that MSW stabilization has occurred. LFG analyses for 8-2-12 (which are prior to the quarterly leachate results starting in 10-9-12) show CH₄ values of 54.2, 61.7, 61.0, 56.2, 61.7, 0.3, 0.1, 44.7, 35.1, 17.7, 58.4, 59.6, 49.9, 47.5, 36.0, and 28.9 volume percent for wells 1 to 16, respectively. Corresponding CO₂ values are: 35.0, 36.9, 34.0, 29.3, 26.2, 0.1, 0.0, 25.7, 26.2, 14.7, 32.9, 32.3, 32.6, 29.8, 29.0 and 30.0.

Several points need to be recognized regarding possible LFG composition trends. First, multiple well results are available and each well is affected by the vacuum applied to the well because low vacuums

will not draw fresh LFG to the wellhead as desired. Second, there are more wells than there are leachate collection points. An alternate point of sampling LFG would be at the intake to the flare where the gas composition would be most strongly affected by the well with the greatest vacuum although it should be a composite of all the GCCS wells even though the wells with the lesser vacuums do not contribute as much gas to the flare as the well(s) with the greatest vacuum(s). Lastly, the state of the MSW stabilization for LFG production varies with the degree of stabilization as shown in Figure 1 for the hypothetical batch stabilization of MSW (7) (Note that actual stabilization curves for MSW landfills can take years to evolve since they depend on the availability of moisture). The ratio of CH₄ to CO₂ increases as time passes from the start of Phase IV to about the midpoint of Phase IV. The decline afterwards is a result of the consumption of the total volatile acids (TVA) which serves as a food source for the methane bacteria as stated previously.

As MSW stabilizes, the LFG gas compositions should level out as shown in the latter part of Phase IV. The key point to note is that gas production will decline as shown in the latter part of Phases IV and V. This would suggest that the best way to determine a trend for LFG is to track gas production. The CH₄/CO₂ ratio can be used as a secondary trend factor for the reasons cited previously.

Figure 1 - Extract from Reference 8



**Figure 1-4. Waste decomposition phases taken from draft
(Modified from Pohland and Harper, 1986)**

Available Results, Trend Analyses Conclusions and Recommendations

Reference 4 states that trends to establish equilibrium of key parameters need to be validated by statistics. Reference 8 gives a procedure (along with an available PowerPoint™ demonstration) to do this using the non-parametric Kendall tau statistic. However, this procedure will not be used to confirm equilibrium for the various emissions reviewed in this section due to the time constraints in doing the numerous evaluations manually. General conclusions will be reached based on the observed (and in some cases an assumed) trend of each of the emission sources under consideration as far as the possibility of activity reduction or termination.

3. Leachates

Table 3 data consists of pre-Subtitle D leachate results from toe drain sampling done by B&M. The data do not include the first five years following closure and only one year (2011) where quarterly samples were taken. There are 15 sets of data covering a nine year period as shown in Figure 2. In general and ignoring what could be called an outlier, it can be concluded that the leachate from the pre-Subtitle D landfill is relatively stable except for a downward trend in COD and NH₃ fluctuations; the latter of which are expected, but are not extreme. Therefore, it is recommended that the toe drain analyte list include COD and NH₃ measurements after 2016 until subsequent equilibrium values are obtained.

Toe drain volumes have been recorded since May 2004. No attempt was made to determine any trends in the volume data but there should be a direct correlation with precipitation data since the pre-Subtitle D unit is an unlined cell, which allows for infiltration through the quarry walls. The pre-Subtitle D area has a composite (clay plus HDPE) final cover. Available toe drain volumes are included in Appendix 3. There are only two data which match the leachate data in Table 3 if one matches a date in Table 3 with a month in Appendix 3; hence, there is only one mass flow value that can be calculated. Also, Table 3 data are for grab samples taken on particular days and Appendix 3 data are haul data for a particular day which are typically not the same day, i.e., leachate sampling did not occur on the same day when the toe drain wet well was emptied into a haul truck for disposal. There should be better comparisons for future values since toe drain analyses and haul data are routinely recorded.

Table 3 – Key Leachate Data for Toe Drain

Sampler	Date	BOD ₅ (mg/L)	COD (mg/L)	TSS (mg/L)	NH ₃ -N (mg/L)	pH
B&M	2-1-06	11	250	6.7	0.55	7.5
B&M	4-19-06	7.0	250	18	80	7.3
B&M	8-2-06	22	290	9.0	68	6.8
B&M	1-25-10	BDL	240	13	54	7.7
B&M	4-14-10	23	190	8.6	46	7.9
B&M	9-1-10	11	180	2.1	10	8.3
B&M	10-13-10	8.1	200	5.6	4.1	7.4
B&M	1-13-11	19	240	3.2	34	7.9
B&M	4-28-11	48	210	32	26	7.9
B&M	7-19-11	18	210	66	3.9	8.4
B&M	10-18-11	30	250	36	150	7.4
B&M	4-19-12	mentioned	but not	available	in GW	report
B&M	10-9-12	10	200	5.9	66	7.0
B&M	4-10-13	11.0	180	12	58	7.0
B&M	10-10-13	mentioned	but not	available	in GW	report
SE (B&M)	4-16-14	7.40	170	18	53	6.7
AEI	10-30-14	5.2	147	1,120	72.3	7.0
	Average	16	214	90	48	7.5
	Average w/o outlier	No outliers	No outliers	16	No outliers	No outliers
	Range	5.2 to 48	147 to 290	2.1 to 1,120	0.55 to 150	6.7 to 8.4
	Range w/o outlier	No outliers	No outliers	2.1 to 66	No outliers	No outliers

Figure 2

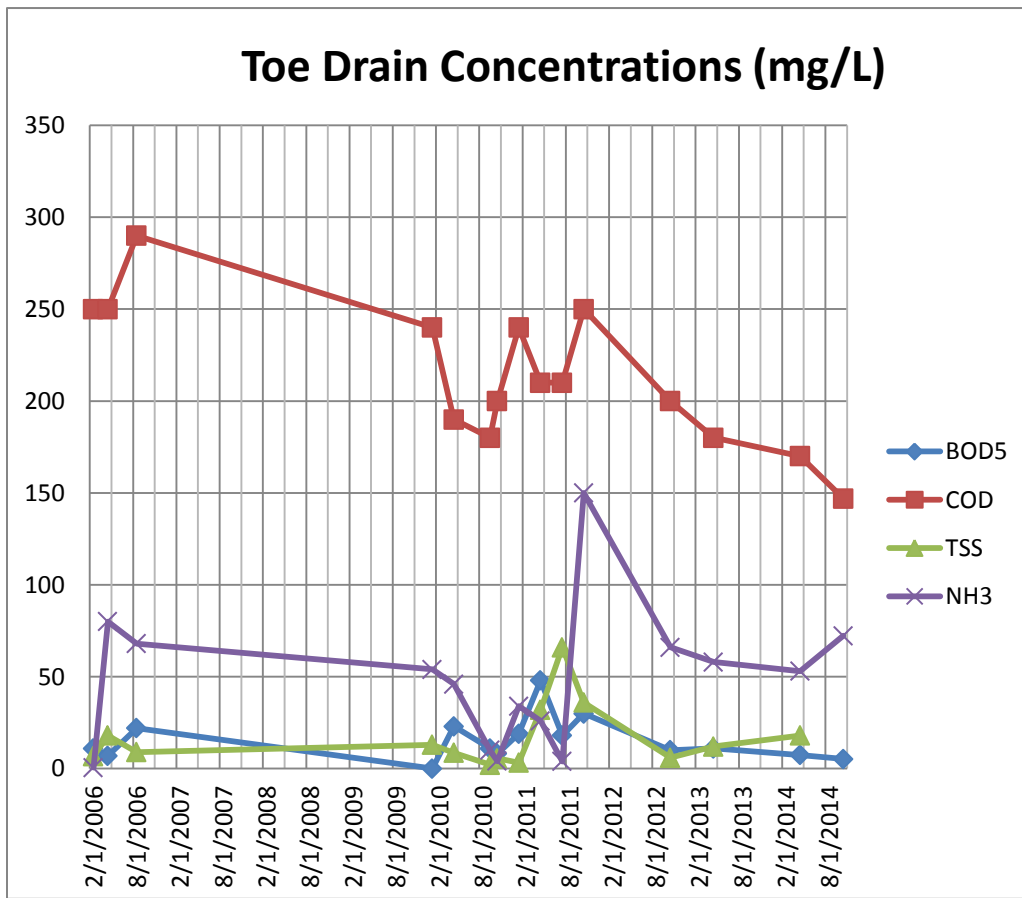


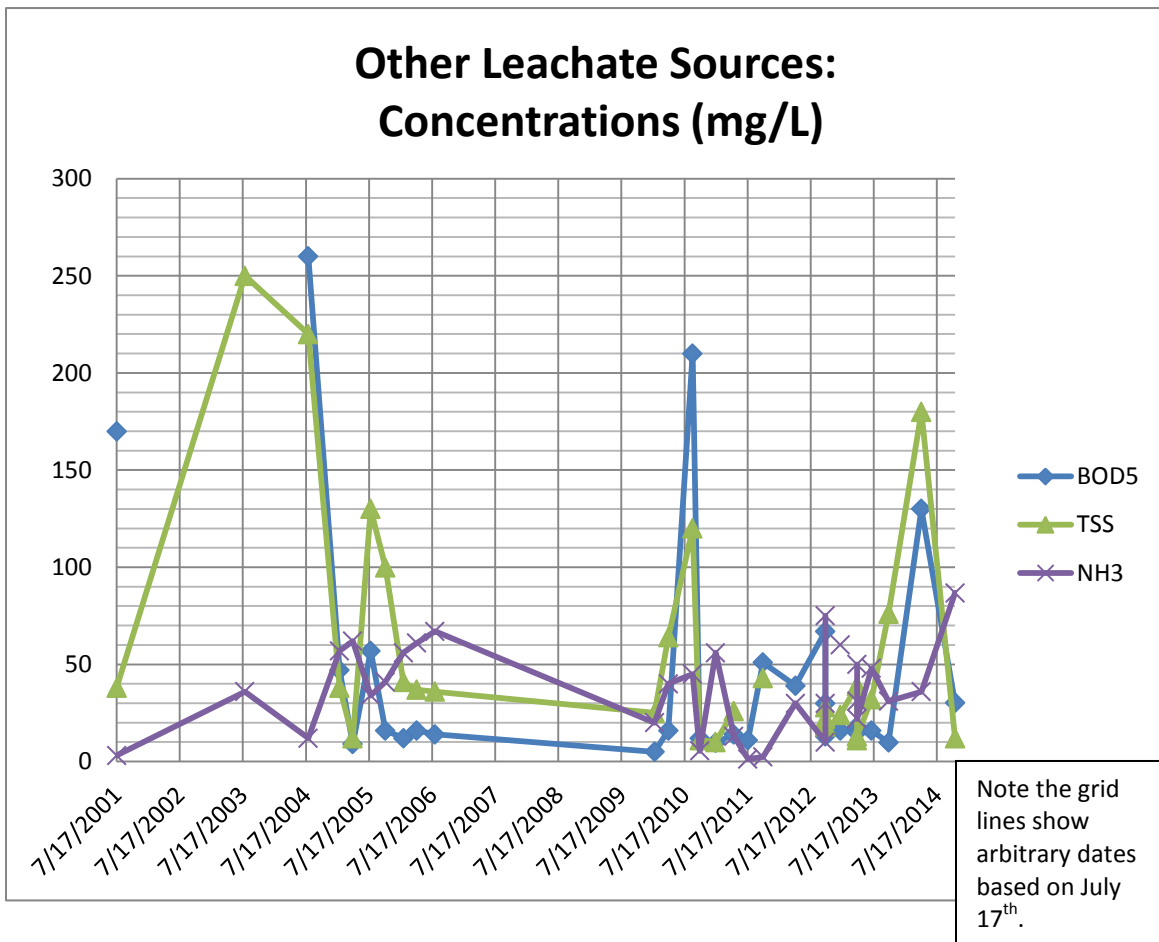
Table 4 and Figure 3 data consist of leachate results for Phases I and II, Cells 1A and 1B, and SEB No. 1 taken by four different samplers: B&M, BWM, Schwab Eaton and AEI. Figure 3 (COD and pH data are omitted) reveals the erratic nature of the data reflecting the different sampling protocols. Table 4 data could represent the first (2010 to 2014) of the three five year periods for each of the parameters for all of the preceding leachate sources. It is assumed that Table 4 data represents the leachate quality for inactive Phases I and II, during the first period if the next two five year periods are based on samples taken only from the Phase's wet well and the three five year results are statistically compatible. The basis for this assumption is that the variability from sampling multiple locations is eliminated.

Table 4 – Key Leachate Data for Other Leachate Sources

Sampler	Date	Location	BOD₅ (mg/L)	COD (mg/L)	TSS (mg/L)	NH₃-N (mg/L)	pH
B&M	7-17-01	Phase I	170	340	38	3.1	6.1
B&M	12-17-02	Phases I & II	NA	20	NA	9.1	NA
B&M	7-29-03*	Phases I & II	1,400	2,200	250	36	6.7
B&M	7-30-04*	Phases I & II	260	500	220	12	6.5
B&M	1-27-05	Phases I & II	47	310	38	57	7.5
B&M	4-13-05	Phases I & II	9	210	12	62	7.6
B&M	7-26-05	Phases I & II	57	1.6	130	34	6.6
B&M	10-19-05	Phases I & II	16	140	100	41	6.7
B&M	2-1-06	Phases I & II	12	270	41	56	6.9
B&M	4-19-06	Phases I & II	16	160	37	61	6.9
B&M	8-2-06	Phases I & II	14	200	36	67	7.6
B&M	1-25-10	SEB No. 1	5	59	25	20	7.3
B&M	4-14-10	SEB No. 1	16	100	64	40	7.6
B&M	9-1-10	SEB No. 1	210	300	120	45	6.8
B&M	10-13-10	SEB No. 1	12	28	11	5.5	7.9
B&M	1-13-11	SEB No. 1	9.6	190	10	56	7.1
B&M	4-28-11	SEB No. 1	14	110	26	13	7.7
B&M	7-19-11	SEB No. 1	11	180	500	1.3	8.5
B&M	10-14-11	SEB No. 1	51	220	43	2.4	8.5
B&M	4-19-12	SEB No. 1	39	410	1,100	30	8
B&M	10-9-12	SEB No. 1	67	370	18	10	8.4
BWM	10-9-12	SEB No. 1	30	370	19	30	8.5
BWM	10-9-12	Phases I & II	13	190	28	75	7.3
BWM	10-9-12	Cell 1A	16	370	22	180	7.2
BWM	1-3-13	Cell 1A	NA	8.8	470	60	7.6
BWM	1-3-13	Phases I & II	16	250	24	NA	7.7
BWM	4-10-13	Phases I & II	17	110	39	50	7.5
BWM	4-10-13	SEB No. 1	18	160	11	31	8.1
B&M	4-10-13	SEB No. 1	15	150	13	22	8.0
BWM	7-3-13	Phases I & II	16	140	32	48	6.8
B&M	10-10-13	SEB No. 1	9.8	130	76	31	8.0
SE(B&M)	4-18-14	Composite of Phases I & II and Cells 1A & 1B	130	160	180	36	7.0
AEI	10-30-14	Same as above	30.2	142	12.0	86.8	6.6
		Average	89	258	117	41	7.4
		Ave. w/o outliers	43	191	52	35	No outliers
		Range	5 to 1,400	1.6 to 2,200	10 to 1,100	1.3 to 180	6.1 to 8.5
		Range w/o outliers	5 to 260	1.6 to 500	10 to 250	1.3 to 86.8	No outliers

*Seven sets of BOD₅ and TSS data collected during the 2003-04 time period were not used. They were part of a B&M report to the Bureau of Water concerning ACL leachate disposal in the LaHarpe POTW. They were not used because companion stabilization data were not available.

Figure 3



Inspection of the bottom part of Table 4 and Figure 3 suggests that the elimination of outliers will also improve the possibility of having the first five year period compatible with the next two periods. Application of the Kendall Tau method to these data could indicate that equilibrium has been obtained for all leachate parameters although it is not recommended for ammonia and pH because they are parameters that should be tracked over time to see if potential increases for ammonia and any change in pH indicated inhibition of bioactivity due to extreme pH levels.

4. Pre-Subtitle D LFG Trends

Compilation of LFG data for the pre-Subtitle D closed site is a more of a challenge because samples are taken monthly for 16 wells, 2 horizontal wells (one well was abandoned in 2012 as part of B&M's landfill GCCS improvement project) and one flare (see Figure 4). This means that for eight LFG measurements, there is about $18 \times 5 \times 12 \times 8$ or 8,640 data. Table 5 and Figure 5 shows Well No. 10 (see Figure 4) data for the period 1-17-10 to 8-2-12 (period of available data to the author at the time of this writing). Well No. 10 is on the southern edge of pre-Subtitle D landfill adjacent to the flare. The velocity and rate values are based on meter readings taken prior to the flare. All other measurements are taken at Well No. 10.

Figure 4 - ACRL Pre-Subtitle D LFG Well No. 10, Blower and Flare Locations (10)

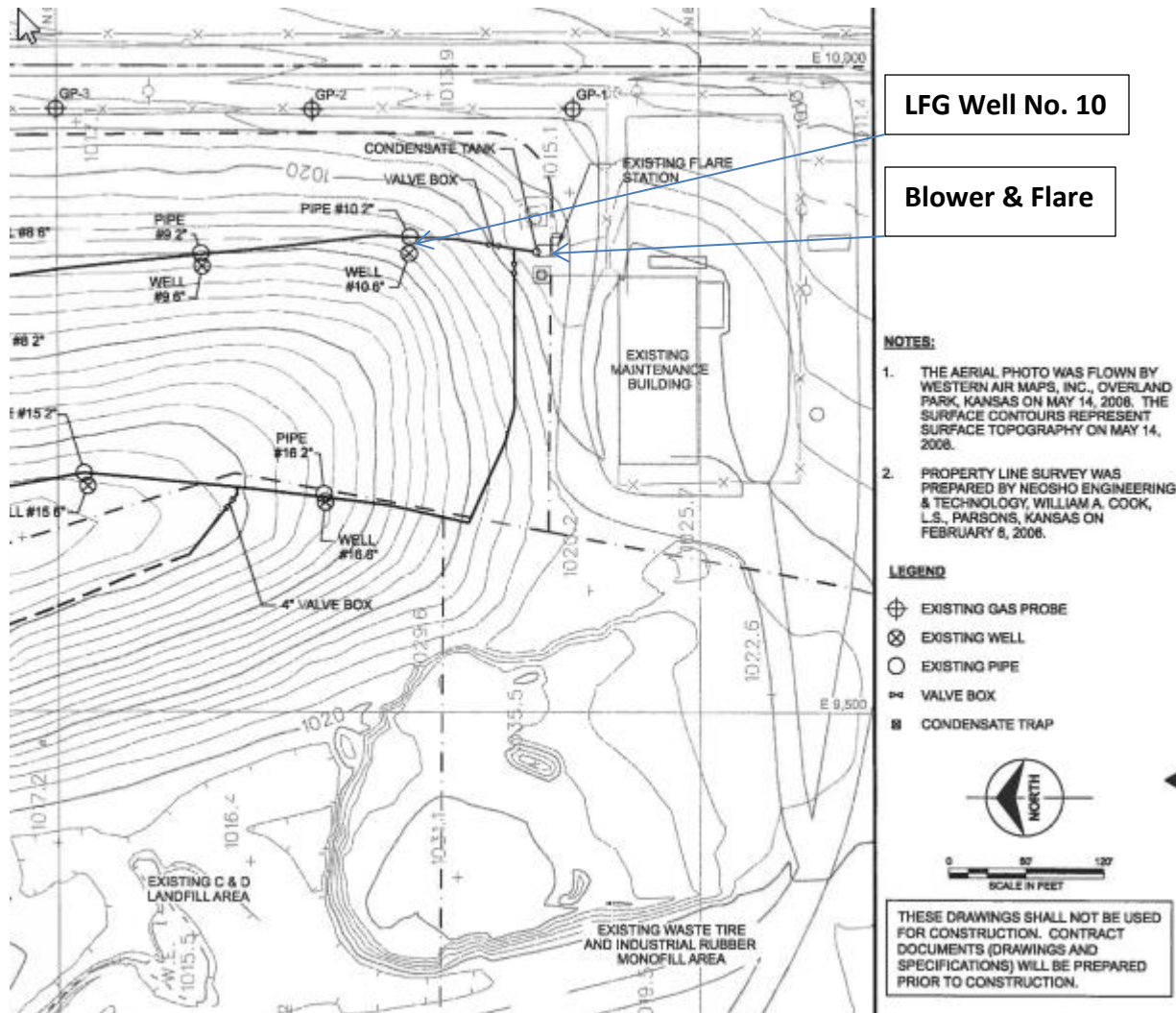
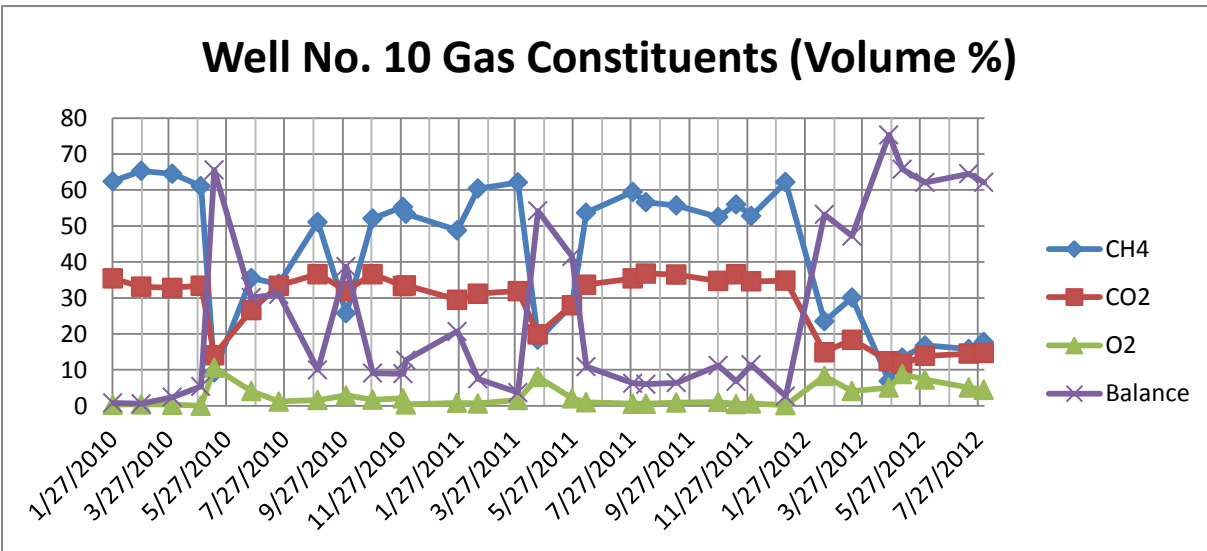


Table 5 – ACRL Pre-Subtitle D Area Blower and LFG Well No. 10 Data

Date	Blower Data		Well 10 Temperature and Composition						
	Velocity (fpm)	Rate (cfpm)	Temperature (°F)	Vacuum (in H ₂ O)	CH ₄ Vol. (%)	CO ₂ Vol. (%)	O ₂ Vol. (%)	Balance (Vol. %)	Sum of LFGs (%)
1-27-10	915	60	46.8	Negative	62.4	35.4	0.3	0.8	98.9
2-26-10	NA	NA	79.5	Negative	65.3	33.1	0.4	0.6	99.4
3-31-10	1,208	98	88.1	Negative	64.5	32.8	0.3	2.4	100
4-30-10	1,409	110	78.0	Negative	61.1	33.4	0.0	5.4	99.9
5-14-10	1,222	100	58.6	0.6	9.3	14.1	10.6	65.6	99.6
6-22-10	1,040	95	98	1.2	35.5	26.6	4.1	30.1	96.3
7-21-10	1,290	100	103.4	0.4	33.9	33.4	1.2	31.0	99.5
8-31-10	1,074	90	80.0	0.1	51.1	36.6	1.6	10.0	99.3
9-30-10	930	65	69.0	0.7	25.7	32.0	2.9	38.7	99.3
10-28-10	1,286	100	63.3	Negative	52.1	36.6	1.7	9.1	99.5
11-29-10	1,099	90	60.2	0.2	55.3	33.3	2.1	8.9	99.6
12-2-10	1,244	90	83.8	Negative	53.4	33.5	0.4	12.7	100
1-25-11	1,439	95	67.8	Negative	48.8	29.5	0.8	20.7	99.8
2-16-11	1,277	95	56.6	Negative	60.4	31.2	0.7	7.5	99.8
3-30-11	1,133	100	53.9	Negative	62.1	31.9	1.6	3.7	99.3
4-20-11	1,353	110	57.5	0.9	18.4	19.9	8.0	54.2	100.5
5-26-11	750	60	75.7	0.7	28.0	28.0	2.1	41.5	99.6
6-10-11	NA	NA	82.2	0.1	53.7	33.7	1.0	10.9	99.3
7-29-11	800	45	101.5	0.3	59.5	35.4	0.6	6.3	101.8
8-12-11	775	65	93.7	0	56.6	36.8	0.6	6.0	100
9-13-11	854	70	118.7	0	55.7	36.5	0.9	6.4	99.5
10-27-11	854	55	57.7	0.1	52.5	34.7	1.1	11.2	99.5
11-15-11	805	52	91.7	Negative	56.0	36.6	0.5	6.8	99.9
12-1-11	800	50	67.4	0.2	52.8	34.6	0.7	11.4	99.5
1-6-12	1,105	NA	75.5	Negative	62.2	34.8	0.2	2.7	99.9
2-16-12	1,530	120	73.9	1.3	23.5	14.9	8.3	53.2	99.9
3-16-12	1,216	100	74.6	0.7	30.1	18.4	4.1	47.2	99.8
4-24-12	1,152	95	72.5	0.2	6.9	12.4	5.1	75.3	99.7
5-8-12	1,533	110	91.4	0.8	13.4	11.7	8.8	65.8	99.7
6-1-12	1,215	110	77.9	0.7	16.8	13.9	7.3	62.1	100.1
7-17-12	1,200	NA	92.6	0.3	15.8	14.5	5.1	64.5	99.9
8-2-12	1,245	110	91.2	0.5	17.7	14.7	4.5	62.1	99

Figure 5



It is apparent that there is a drop off in MSW stabilization since both methane and carbon dioxide concentrations are reduced in the zone of influence of Well No. 10 beginning in February 2012. This trend doesn't exist for the other wells (which would be expected) since different parts of the site receive more moisture than others; hence, the reduction in monitoring activities for LFG wells would have to be determined for each well. Figure 1 (or Figure 1.4) does not provide information about the time required for the slopes of the methane and carbon dioxide curves to reach their peaks and to gradually decline. Therefore, it is necessary to track each well to confirm that it has reached equilibrium.

Conclusions

Existing monitoring data and assumed future trends suggest that it is likely that leachate monitoring activities (BOD₅, COD and TSS) can be terminated for pre-Subtitle D toe drain by 2017; also, the monitoring of existing LFG wells. However, as subsequent units are equipped with GCCSs, then additional LFG monitoring will be required. Groundwater monitoring will continue in all existing and future wells for the landfill's life, but at a decreasing intensity during its post closure care period. In general, groundwater wells will be plugged and abandoned if they are in the future landfill disposal footprints.

Recommendations

There are two aspects of the preceding conclusions which need to be considered. First, all monitoring activities will continue so that the suggested trends can be established and validated statistically by the designated year. Secondly, cost estimate calculations for financial assurance (FA) requirements should be made using the selected reduction and/or termination of activities (monitoring and related activities). The reduced amount of FA required will serve as the basis for the preparation of an **ACRL Report**.

Financial Assurance Considerations

The ACRL FA for closure, postclosure or corrective actions costs is provided by the local government financial test. Private landfills that own their own land can use any FA method. Landfills that do not own their land must meet their FA obligations by a purchased financial instrument, i.e., a trust fund, surety bond, irrevocable letter of credit and/or an insurance policy. Significant savings can be realized in FA costs when postclosure unit or landfill activities can be reduced or terminated as soon as possible after closure. This lowers the FA cost estimates by reducing the rolling 30 costs to lesser durations. A hypothetical example using ACRL PCC FA cost data is given in the following paragraphs.

Reference 11 is the PCC cost estimate that was submitted with the ACRL's 2014 permit renewal. Note that it only presents post-closure costs that would be incurred if the ACRL closed during the 2014-2015 permit year and does not include post-closure costs associated with future phases. Also, the costs presented are third party costs, while some of the items (e.g., gas monitoring) are currently performed by ACRL employees. For the purposes of this discussion it is assumed the costs presented are approximately the costs to ACRL. An examination of the estimated 30 year PCC ACRL FA costs presented in Reference 11 (and summarized in the 2014 column of Table 6) shows that less than 12 percent of the annual post-closure costs are due to the leachate (LCCS) and gas (GCCS) collection and control systems. The LCCS O&M costs will not be affected because **Subpart WWW** requires that the LCCS system be operated until the landfill (defined as the total disposal area) has ceased receiving waste and a closure report submitted; and it has been verified by three successive tests dated at least 90 days apart that the landfill is emitting less than 50 Mg NMOC per year. To terminate LCCS operations it is also required that the LCCS has been in operation for at least 15 years. This is a requirement easily met due to the ACRL's long projected life.

The ACRL has 12 property line gas monitoring probes which the PCC worksheet's Lines 7.0.2 plus 7.03 indicate cost \$2,800 annually to physically monitor, with Line 7.0.4 indicating about \$1,600 is required for bookkeeping, adding to annual total cost of \$4,400. Eleven of the 12 probes monitor property line that is only in proximity to the pre-Subtitle D cell indicating that physical monitoring costs can be reduced by approximately eleven-twelfths to about \$233 annually. Bookkeeping costs do not necessarily reduce proportionate to probe count, so these costs are reduced by three quarters to an estimated \$400 annually. Thus, estimated gas monitoring expenses presented on the post-closure care worksheet can be reduced from \$4,400 to annually to about \$633 annually, a \$3,766 reduction.

Because the pre-Subtitle D cell toe drain operates by gravity drainage, the primary expense reduction incurred by pre-Subtitle D area waste stabilization would be a reduction in sample collection and analyses (Reference 11's Lines 5.0.7 and 5.0.8). Subsequent to Reference 11's preparation, and as presented in this paper, leachate sampling at the ACRL has been revised to collect and analyze samples from three unique locations and line 5.0.8 should present six, not two analyses, increasing Line 5.0.9's annual leachate system total costs from \$8,330.20 to \$12,762.20. Assuming that eliminating toe drain sampling has only a slight effect on sample collection costs, sampling from three locations twice per year would result in six analyses per year, an addition of four analyses, increasing Line 5.0.9's annual leachate system total costs from \$8,330.20 to \$12,762.20. Thus, the analyses costs reduction is based going from six to four analyses per year (\$6,648 to \$4,432 per year), a reduction of \$2,216 per year.

The table below, based on data from ACRL's 2014 permit renewal, presents the potential reduction in PCC FA that can be achieved by the reduced monitoring requirements described above, and possible operational savings that that can be achieved by reduced monitoring requirements when the unit is in PCC.

Table 6 – Example Projected PCC Annual Costs for FA Purposes

Closure Cost Estimate Year	2014*	Adjusted 2014
Affected Units	All units	Reduced pre-Subtitle D Monitoring Costs
Annual Costs	\$152,516	\$144,738
Annual Savings	-	\$7,778
30 Year Costs	\$4,575,471	\$4,342,134
30 Year Savings		\$233,337

* See Appendix 4 which is an extract from ACL's 2014 Permit Renewal (11).

Postscript

Much of what is presented in this document is based on data that were not collected for the designated purpose of this document, i.e., preparing an **ACRL Report** (4). This was pointed out with regard to leachate and LFG sampling results. Guidance is available to produce the best results for both emissions (12, 13). Also, companion data, e.g., flow data with date coordinated sampling values, must be collected if emission analysis results are to have their greatest value (4). As stated previously, such data were not collected since that collection was not required by regulations or by an approved FOP, closure plan, postclosure plan or **ACRL Plan** (PCC plan); and was extraneous (not required data collection at that time). Also, if more reliable flow data had been recorded, then more definitive conclusions could have been reached by this **ACRL Report**.

BWM Solid waste Permit Section engineers have been equipped to assist landfill O/O in perfecting their sampling and other data collection skills so that a comprehensive **ACRL Report** can be prepared. It is imperative that O/O (with available supporting personnel: consultants and/or laboratory samplers) utilize BWM resources cited in this document if a proposed **ACRL Report** is to receive BWM ap